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WORLD PETROLEUM

NEW YORK AND LONDON

SEPTEMBER 1937

GEOLOGY AND ECONOMIC SIGNIFICANCE OF HASTINGS FIELD

JERSEY STANDARD TO REMAIN IN ARGENTINA

AUSTRALIA'S SEARCH FOR OIL

JAPANESE OIL POLICY

FOR A TRUE RUN

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Riveting an oil tank to be used for Germany's extensive storage of crude and refined products. Photograph by Dr. Nobert Lauffs.

EDITORIAL

TELLING THE REASON TO THE PUBLIC

MUCH favorable comment has been called forth by the statement made by President Farish of Standard Oil Company (New Jersey) a fortnight ago that hereafter, in making announcement of price changes his company would give the reason for such changes. The remarkable point about this is, not that it was received with favor, but that it should not have become general practice long ago.

There are, of course, numerous causes that may lead to an advance or a decline in wholesale or retail prices. Whatever may be the responsible reason in a particular case it is a matter of simple justice to the consuming public that it be informed. Likewise, in fairness to itself a company that alters prices should tell what led to its action. Presumably there are sound reasons back of any change but if they are not stated the ultimate buyer is apt to assume that every advance represents an arbitrary action designed to add unneeded profits. When declines take place he is likely to accept them as a "break" in his favor without inquiring particularly into the causes that brought them about.

While it is true that the factors influencing price changes in gasoline are broadly the same that affect other commodities, that is, supply and demand, competition, raw material and manufacturing costs, wages and taxes this does not make them unimportant to those whose pocketbooks are affected. It is particularly important to make plain to the ultimate buyer the precise operation of these general influences that causes them to affect his personal economy. As Mr. Farish points out it is not enough that industry itself be aware of its high principles and the fairness of its prices. The public must be shown.

A convincing example of how the industry may suffer from failure to do this is provided by the history of petroleum taxation in the United States.

Those who have studied the constantly growing burden of state, federal and local taxes upon petroleum products in the United States, a load that will approach or possibly reach a total of $1,500,000,000 in 1937, are agreed that its growing incidence has been accepted with slight protest by consumers because they were not fully aware of what was happening. During the time when the tax load has been increasing by addition of a cent a gallon here and another cent there the petroleum industry itself has been busily absorbed in devising methods of reducing costs of manufacture and distribution, getting more gallons of gasoline out of a barrel of crude and improving the quality of fuel and lubricants produced without adding to the price paid by the consumer. While the retail price of motor fuel is roughly the same as twenty-five years ago the wholesale price (ex-tax) is substantially less. The progress made in the petroleum industry during this period has not gone to benefit the consumer as it otherwise would have gone, but it has been absorbed in higher taxes. As a result the industry has not recieved credit for the remarkable cheapening of its products nor have tax-creating bodies encountered the opposition that would have arisen had the tax paying public been more fully informed of what was going on. Particularly in the numerous cases where taxes laid on petroleum products are used for general expenses or for objects that have no relation to the purpose of maintaining and improving public highways for which petroleum taxes were originally laid experience has shown that motorists will make strong and frequently effective protest if they are acquainted with the exact situation.

WHILE the subject of taxation is not the only one on which it is desirable to have the public informed it is an important one and is likely to remain so because the constantly increasing cost of doing business, not only in the oil trade but in all kinds of industrial activities, traces back in most instances to some new form of taxation or to costs incurred in complying with governmental regulations and requirements in reports and answers to questionnaires. Security and old age taxes, reduction in depletion allowances, taxes on undistributed profits, sales taxes and a multitude of impo ts upon the privilege of doing business in a state or municipality add, each its bit, to the expense of carrying on the simplest forms of industry and trade. In the aggregate they create a burden of no small proportions which must be passed on to the ultimate consumer of the products affected. Since he must pay the footing he is entitled at least to a clear understanding of the situation. In the final analysis he is the only one that can do anything to change it.

MEXICO FACES CRITICAL DECISION ON OIL POLICY

SPEAKING at Merida on the special problems of Yucatan and the plans of the government for dealing with these through socialization of the land and by other measures President Cardenas of Mexico took occasion to appeal to labor organizations throughout the country to desist from strike activities which threatened to delay rather than assist in the realization of the government's program for general betterment of the people. While the President did not particularize it is fair to assume that one thing he had in mind, among others, was the long series of strikes that has burdened the oil industry to the detriment of the national economy and the serious loss of the federal treasury.

This series of outbreaks has passed far beyond the scope of ordinary industrial conflicts over wages and hours. It has raised the issue whether oil workers are to be set up as a special favored class to receive benefits which can be conferred only at the expense of all other members of the body politic. It presents the collateral question whether a small group of leaders of organized labor are to become the real rulers of Mexico, overriding the government itself and imposing their will upon all other classes of citizens.

The latest pronunciamento of this group, presented as a culmination of previous extraordinary demands and approved after cursory examination by a special commission, puts squarely before the Cardenas administration decision as to whether it will maintain or destroy the great petroleum industry which over many years has supplied vast revenues to the nation and contributed greatly to its commercial prosperity.

Some of the provisions which the oil companies are asked to accept are difficult for an outsider to credit as being offered seriously. They include the establishment of a forty hour week with fifty-six hours pay, free life insurance and pensions of 85 percent of the wage received at date of retirement, vacations of one month each year with full pay, payment of 80 percent of full wages during periods of illness up to four months and full pay while on strike without limit as to time. These requirements, in addition to the increase in wages proposed by the commission, would add, according to the estimates of the oil companies, roundly $15,000,000 to the annual expense of operation. Comparing this with their total net income of $6,600,000 in 1935, the most profitable of recent years, gives a concise picture of the situation confronting the industry.

CERTAIN facts seem to be accepted without controversy. One is that the wages paid to oil company employes are the highest received by any class of industrial workers in Mexico, that they have been increased 60 percent since 1934, and that the companies voluntarily have provided additional social benefits, savings funds, schools, free medical service, accident compensation and holiday pay far in advance of the requirements of existing law.

These progressive policies, instead of being accepted as an indication of the companies' desire to raise the standard of living of their employes, apparently have created the belief that the oil industry is an inexhaustible source of wealth which can be drawn upon indefinitely for purposes of revenue or for gratification of the most extreme demands the workers choose to make. The mere circumstance that during the past ten years the companies have been able to realize no more than 4.25 percent upon their invested capital apparently has no dampening effect upon this optimistic expectation.

Rising taxation and rising costs of labor can be met in only two ways. One is by advancing rates to consumers; the other is by expanding the volume of operations and increasing the productivity of workers. In Mexico the first of these possible escapes has been denied the oil companies through the fixing of retail prices by government decree. Although prices of petroleum products have been advancing in practically every part of the world in Mexico they have remained approximately at the low levels of two years ago. Instead of expanding output it is well known that production has dropped to 20 percent of its peak figures in 1921.

According to the opinions of competent engineers this falling off has been due not to the exhaustion of Mexico's petroleum resources but to insecurity in the tenure of holdings, illiberality in the granting of drilling permits and other obstructions to development that have made it impossible for the international companies to keep up an adequate amount of exploration and drilling and at the same time have made it advantageous for them to obtain their supplies of crude and products from South America and the Near East.

LOOKING at the situation in its broadest aspects it appears that the outside world would suffer far less from dispensing with the oil supplies it now draws from Mexico than would Mexico from sacrificing its place in the world market. Petroleum exports help the trade balance of Mexico to the extent of many millions yearly. The oil industry up to last year had paid the government in taxes nearly $250,000,000. With the building of improved highways and the consequent growth of demand it is estimated that motor fuel taxes during the current year will bring to the government nearly $14,000,000.

The oil companies of course do not want to abandon their investments of roundly $500,000,000 in Mexico. It is to their advantage to live in harmonious relations with the government authorities and with their own employes if it can be done. Before the appointment of the commission against whose award they are now protesting they offered a large increase in wages and other substantial advantages to their workers. But in justice to their stockholders they must resist attempts to take away their property by forcing them to operate at a loss.

Under the circumstances disclosed it would seem to be decidedly in the interest of the government to arrive at an understanding with the companies that would permit them not merely to continue in existence but to develop the latent resources of the country and to restore to the Mexican petroleum industry something of its former international importance. Aside from any question of justice to the companies such a course would enhance the public revenues by additions which the government needs and it would avoid the class conflicts which sooner or later will become inevitable if the practice is continued of heaping upon one small group of workers favors which cannot be extended to others.

ARGENTINE SITUATION Cleared by Marketing Agreement

Three Leading Companies Form Undertaking to Run Until 1941 or Longer—Monopoly Project Put in Background—Standard Will Retain Its Position.

BUENOS AIRES, JULY 28

GOVERNMENT approval of an agreement recently arrived at by the Yacimientos Petroliferos Fiscales (YPF) and the local companies representing the Shell and Standard of New Jersey interests assures stability in the Argentine market for at least the next three and a half years and for that length of time ends the difficulties which threatened to cause the withdrawal of the Standard's subsidiaries from the country.

For the information of readers who have not followed closely the sequence of events in Argentina during the past year it may be stated that in July 1936 an executive decree was issued which forbade the import of crude oil and products except by special license and placed the fixing of import quotas in the hands of Yacimientos Petroliferos Fiscales, government controlled oil company. The explanation given for this action was that the government desired to have indigenous crude utilized so far as possible in supplying the market for petroleum products and that for reasons of exchange it wished to limit imports strictly to the quantity necessary to fill the gap between domestic production and total market requirements.

To the international companies that had been operating for many years in Argentina the situation in which they were placed by this decree was most unsatisfactory and, from their point of view, most unfair, since the YPF was an active competitor in the sale of products. Of the larger companies the Standard group was in the most vulnerable position because its crude production within the country was relatively small. While Shell was an importer it had a considerable production in the important Commodoro Rivadavia field. In passing it may be mentioned that the international companies had been criticised by the government at various times for not developing a larger production within the country. To this charge the very effective reply was made that while the companies were ready and anxious to explore and drill new areas they were prevented by the government itself through its practice of withdrawing every promising field into the national reserve.

To make the situation worse from the viewpoint of the independent companies the Municipal Council of Buenos Aires, in October last, granted to the YPF exclusive rights to the sale of gasoline within the city. Not only is this metropolitan area the most important market in the country, using nearly a third of all the petroleum products consumed within the country, but it is the most desirable market. This is due to the fact that the government has decreed that products must be sold at uniform prices in all parts of Argentina. This meant that in the more remote districts and in sections where demand was light gasoline had to be sold at a loss.

With the prospect of being barred entirely from the most lucrative market and being forced to limit their distribution to districts where there was small chance of profit the outlook for the international companies was decidedly dark. The claim was made that the government was moving to create a monopoly in the hands of the YPF and to force its competitors out of the market. It was at this juncture that negotiations were started looking to the sale of Standard's properties to the government. A contract covering the sale was drawn up but it did not go into effect because of the failure of Congress to make the appropriation needed to consummate the purchase.

Meanwhile the project for a monopoly to the YPF in Buenos Aires encountered difficulties. A difference of opinion developed between the Council and the Mayor through the action of the latter in vetoing one article of the ordinance. The Mayor subsequently entered into a contract with the YPF by which the latter was to acquire exclusive rights from July 1, 1937. This contract, as well as the ordinance under which it was made, was annulled by the Council in May of this year.

In justice to the YPF must be mentioned its assertion that it was not seeking to establish a monopoly. Its position as defined by President Rafael Silveyra has been that while, by virtue of its relationship with the government, it was the guardian of the national interests it had no desire to exclude other companies from participation in the market. The claim appears to be substantiated, to a certain degree at least, by the agreement recently concluded between the YPF, the Shell and Standard interests. In this agreement the YPF is acting for the small marketers with whom it had reached an earlier arrangement so that the contract now set up covers the operations of all the marketers.

The agreement is based on a figure of 965,000,000 liters (254,953,000 gals.) as representing the annual requirements of Argentina in the matter of gasoline. Of this total 300,000,000 liters (79,260,000 gals.) are specified as the amount needed for the Buenos Aires district and 665,000,000 (175,393,000 gals.) for the interior of the country. Of this total quantity 473,075,304 liters (124,986,495 gals.) or slightly less than half, are assigned to the YPF, including the smaller companies with which it had previously reached an agreement. This quota is divided, 189,780,000 liters (50,139,876 gals.) to the capital district and 283,295,304 liters (64,846,619 gals.) to the interior. The Shell group receives a quota of 38,370,000 liters (10,137,354 gals.) for the metropolitan area and 166,000,000 liters (43,857,200 gals.) for the remainder of the country. The Standard group is allowed 71,850,000 liters (18,982,770 gals.) for the Buenos Aires section and 215,704,696 liters (56,989,191 gals.) for distribution in other parts of the country.

In this division, it will be observed, the YPF takes the larger share of the preferred market in the Buenos Aires territory, slightly over 60 percent, but the assignment of quotas is said to be based approximately on the prior position of each interest. The YPF receives preferred treatment in any increase of consumption above the figure of 965,000,000 liters, but any decrease in consumption is to be shared proportionately.

Utilization of domestic crude to the full extent that it is available is emphasized by the contract. Imports are to be authorized to cover the difference between indigenous production and total requirements. The government's objective is to supply the whole internal consumption from domestic sources. While there has been an increase in production this year it has come from the intensification of drilling in established fields rather than from the

(Continued on page 76)

GEOLOGY AND ECONOMIC SIGNIFICANCE

of Hastings Field Brazoria County, Texas

By M. T. Halbouty (1)

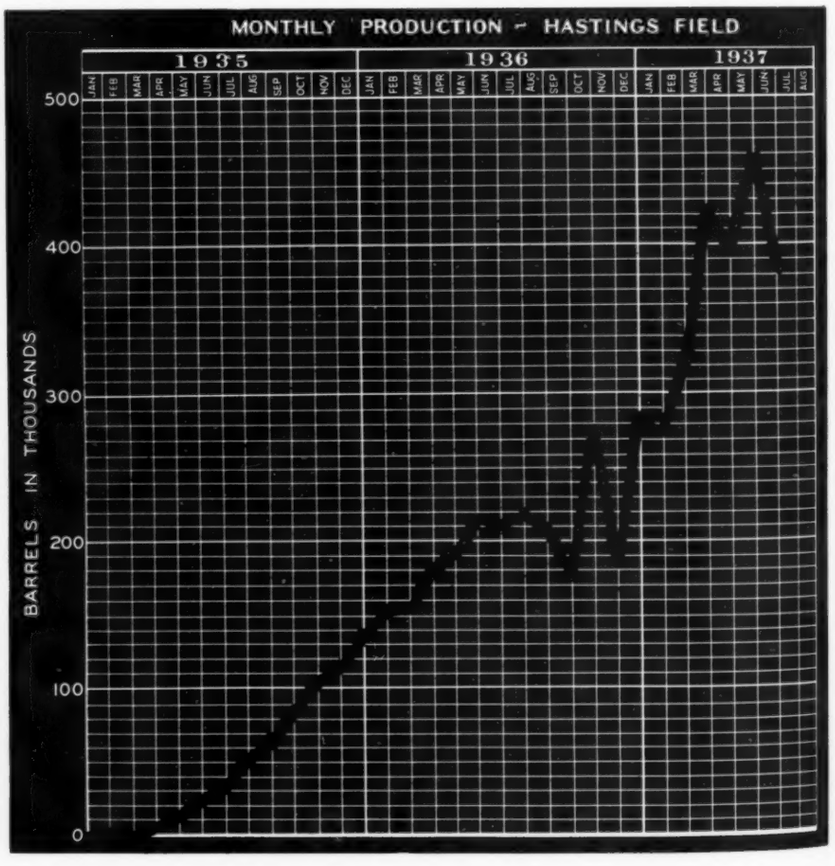
Ninth of a Series of Articles Dealing With the Geology, Reserves and Economy of the More Important Oil Fields Throughout the World

HASTINGS oil field is considered today as the leading and most prolific oil field in the Texas Gulf Coast and is considered as one having a thicker sand section than any ever found in the coastal territory. Hastings is located in Brazoria and Galveston Counties, approximately five miles north of the town of Alvin and eighteen miles south of the city of Houston. It is easily accessible by roads, as State Highway No. 35 passes through the field. Hastings is located in one of the most prolific sections of the Texas Gulf Coast, being literally surrounded by major oil fields. The sand condition in this area is extremely favorable, which has made other prospects in the vicinity so called "hot" prospects.

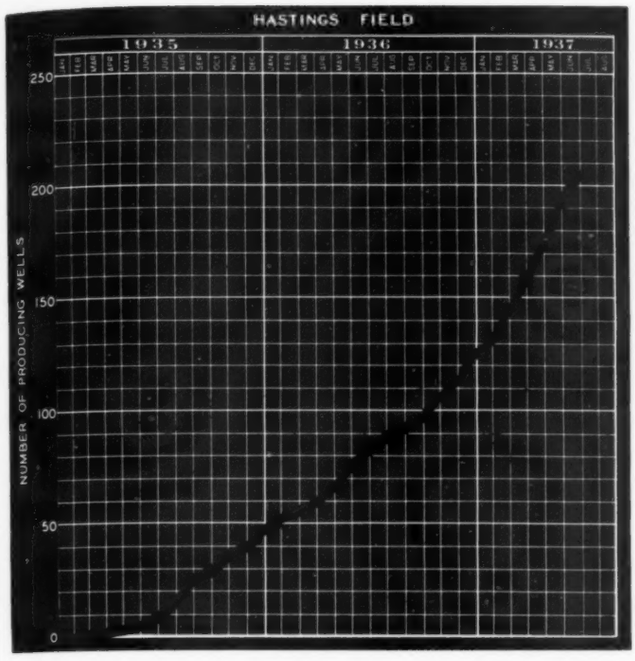
The proven fields near Hastings are Manvel, which is located approximately five miles northwest of Hastings; Mykawa, which is located approximately eight miles north; South Houston, which is located approximately ten miles northeast; Danbury, which is located approximately fifteen miles southwest; and Dickinson, which is located approximately fifteen miles southeast. The "hot" prospects in the area are Alvin, which is located approximately four miles southwest of Hastings; Arcola, which is located eight miles northwest; Chanango, which is located approximately twenty miles south; Pearland, which is located four miles north; Friendswood which is located two miles east of Hastings, and Genoa, located two miles north of Friendswood. One of these, namely the Friendswood prospect, was definitely proven as an oil field when the Humble Company brought in its J. J. Settegest No. 1, located on their 2,500 acre block, two miles east of the Hastings Field. This new discovery was completed July 11, 1937. In the Friendswood producer, the formation intervals and producing horizons are the same as in Hastings and although the new field is located so close to Hastings that it could easily be called an extension, it is, nevertheless, a separate structure lying on the same geological strike-trend as Hastings. From this new discovery alone, it is very evident that any of the prospects that lie in the immediate area could be classified as having favorable possibilities.

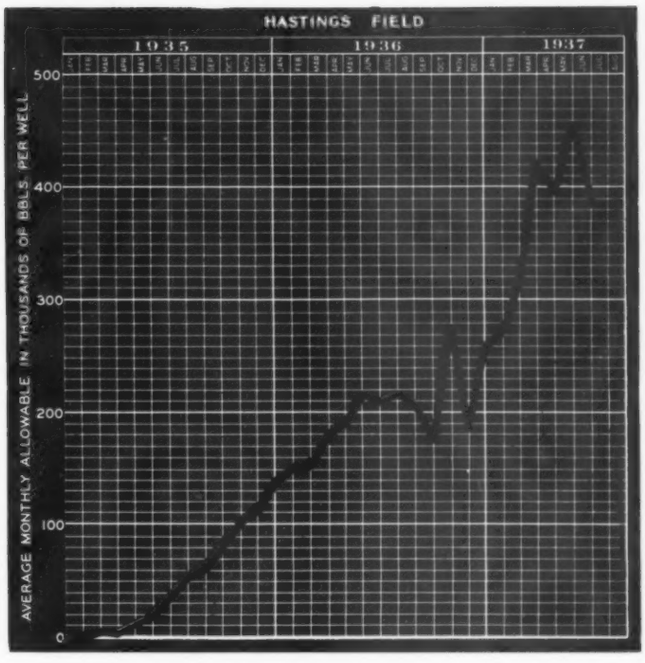
The Hastings field to date has a relatively short history, as activity in the field began in the spring of 1934 and production was obtained on the structure in January, 1935. Stanolind Oil and Gas Company owns approximately 75 percent of the field, the Humble Oil and Refining Company, 20 percent, and the remainder is owned by independent operators. The actual discovery of the field was made by Stanolind Oil and Gas Company with its J. W. Surface, No. 1, which was initially brought in on December 23, 1934 for a production test of 120 bbl., 38 gravity oil, 3,000,000 cu. ft. of gas daily. In this test, oil sands were logged from 5,975 ft. to 5,985 ft. The well was immediately deepened after this production test and carried down to 6,003 ft. and another production test was made on sands logged at 5,985 to 6,003 ft. and on production, the well made 240 bbl. daily of the same gravity oil as the original test. However, due to mechanical difficulties caused by the setting of a screen, the well was cleaned and deepened to 6,154 ft. where it tested salt water, establishing the water level at 6,130 ft., actual measurement. The hole was plugged back to 6,118 ft. where it made a good producer, flowing 268 bbl. per day through a 3/16 in. choke with a tubing pressure of 750 lbs. and a casing pressure of 1,000 lbs. The well was finally completed in January, 1935.

Being near the back door of the city of



1 Vice-President, Chief Geologist and Petroleum Engineer, Merit Oil Corporation of Texas, Houston, Texas.



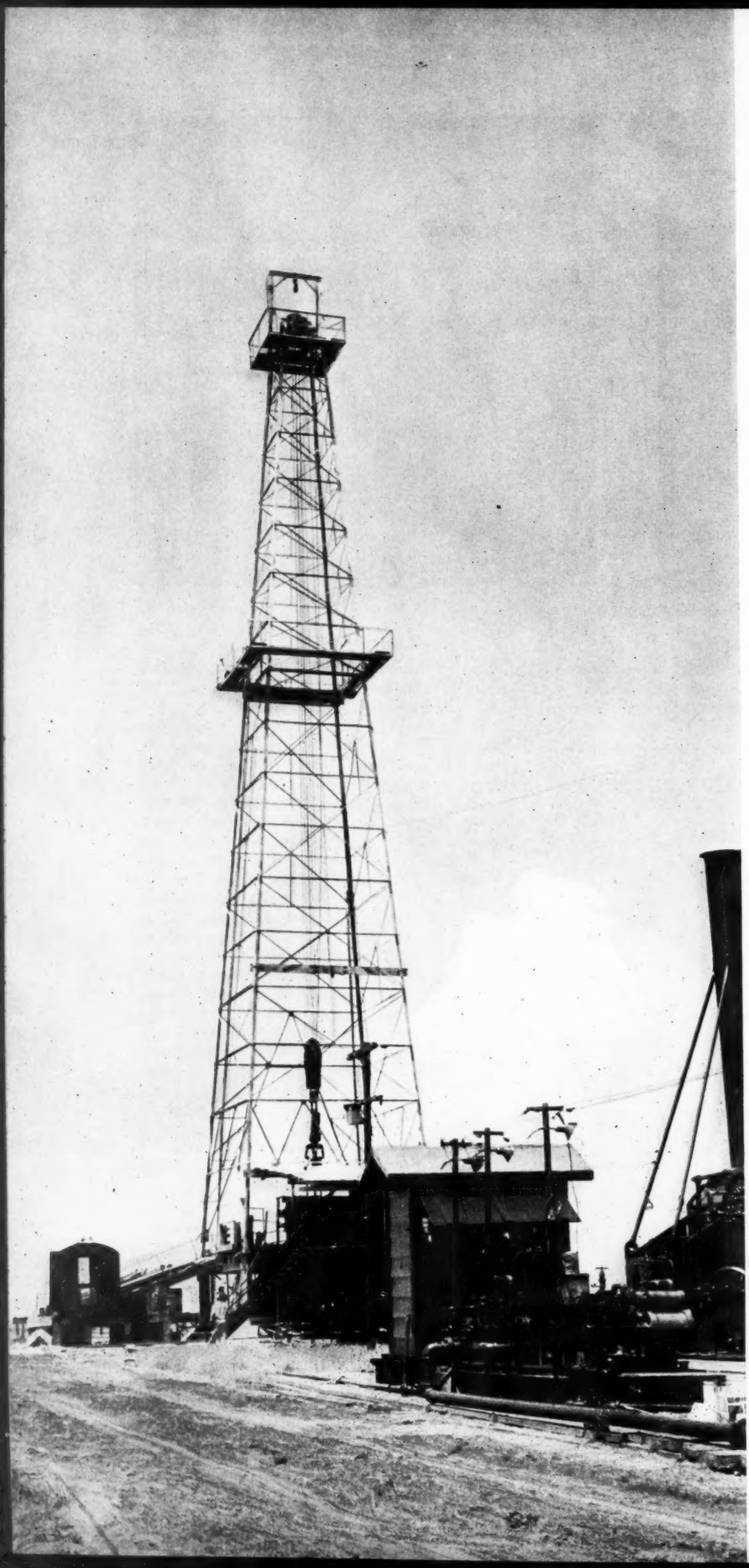


Houston, it seems that its operators had neglected to check the nearby Hastings area for possible structure by geophysical methods, and the area remained dormant until the Stanolind Oil and Gas Company moved into the Gulf Coast area. In the spring of 1934, the Stanolind Oil and Gas Company checked the area by means of the torsion balance instrument and the anomalies showed very high relief with perfect closures on all sides. In this Gulf Coast it is usually the practice of companies first to check an area for any irregularities with the torsion balance, which is called "reconnaissance work" and then later, if any abnormality is evident, to check the area in detail with the reflection seismograph instrument. This initial work with the torsion balance is done in order to cover more ground per working day as the torsion balance is faster and more economical in operation than the seismograph. Even though a very favorable picture, or structure is determined by the torsion balance, the final analyses, or conclusions, are based on the results of the seismograph. It is known that, in the Gulf Coast, torsion balance closures often shift as much as two miles from the actual structure. Gravitational influences are sometimes so strong in an area as to cause such an error. Therefore, it was proper that, even with such a good torsion balance picture as was obtained, the Stanolind should check the torsion balance work with the seismograph. Accordingly, the seismograph detailed the area by the reflection method in the summer of 1934 and this work checked the torsion balance data very accurately without shifting the position of the structure as it was originally determined by the torsion balance. Evidently the torsion balance work was done very accurately and, also, the uplift was so high that the gravitational anomalies registered by the torsion balance were strong enough to record the actual structural area without the possibility of gravitational error.

Stanolind Oil and Gas Company acquired by leases practically all of the structure as shown by the reflection data. Before drilling operations began, Standard Oil Company of Kansas worked the area by the reflection seismograph and, not having any leases available on the structure, the Kansas Company bought a large block of royalty on the leases acquired by the Stanolind Company. No time was lost in commencing the drilling of a well on the structure to determine oil production and the Stanolind Oil and Gas Company located its J. W. Surface No. 1, 446 ft. from the south line and 1,490 ft. from the east line of the A.C.H. & B. Section No. 2. Drilling was actually started on the 29th day of October, 1934 and was finally completed as a satisfactory producer on the 13th day of January, 1935. Drilling activity in the field has progressed very rapidly and to date there are 266 producing wells in the field and 5 dry holes.

The general shape of the field is circular and covers an area of approximately 6 square miles. The production area has progressed beyond the limits of the original seismograph structure; several extensions being made in the last year. Faulting has greatly affected the producing sand and even though the general shape of the field is circular, the productive area is quite irregular. On the original structure, as determined by the seismograph, the Stanolind Oil and Gas Company controlled over 98 percent of the producing area as it was gradually proven; however, in the past few months, the Humble Company extended the field to the northeast where it controls the majority of the leases in that extension. The actual discovery, or the extension of this northeast side, is credited to Walter Goldston, independent operator of Houston, Texas. Stanolind has recently extended the field to the northwest, also to the southwest and southeast.

At the present time, it is evident that in some parts of the field a twin well will have to be made near already producing wells because it has been established that two producing horizons exist in the field and that each producing horizon warrants a well. The firm of Showers and Moncrief proved this condition by drilling a twin well on their Leta Hughey ten acre tract located in the H. T. & B Section No. 29. The first well drilled on this tract was bottomed at 6,080 ft. and produced from the so-called "6,000-ft. sand," and the No. 2 well, which is 100 ft. east of the No. 1 on the same tract was bottomed at 6,790 ft., producing from the so-called "5,800-ft. sand." These two wells are separated by a shale break of 125 ft. The acreage ruling in the field was set by the Texas Railroad



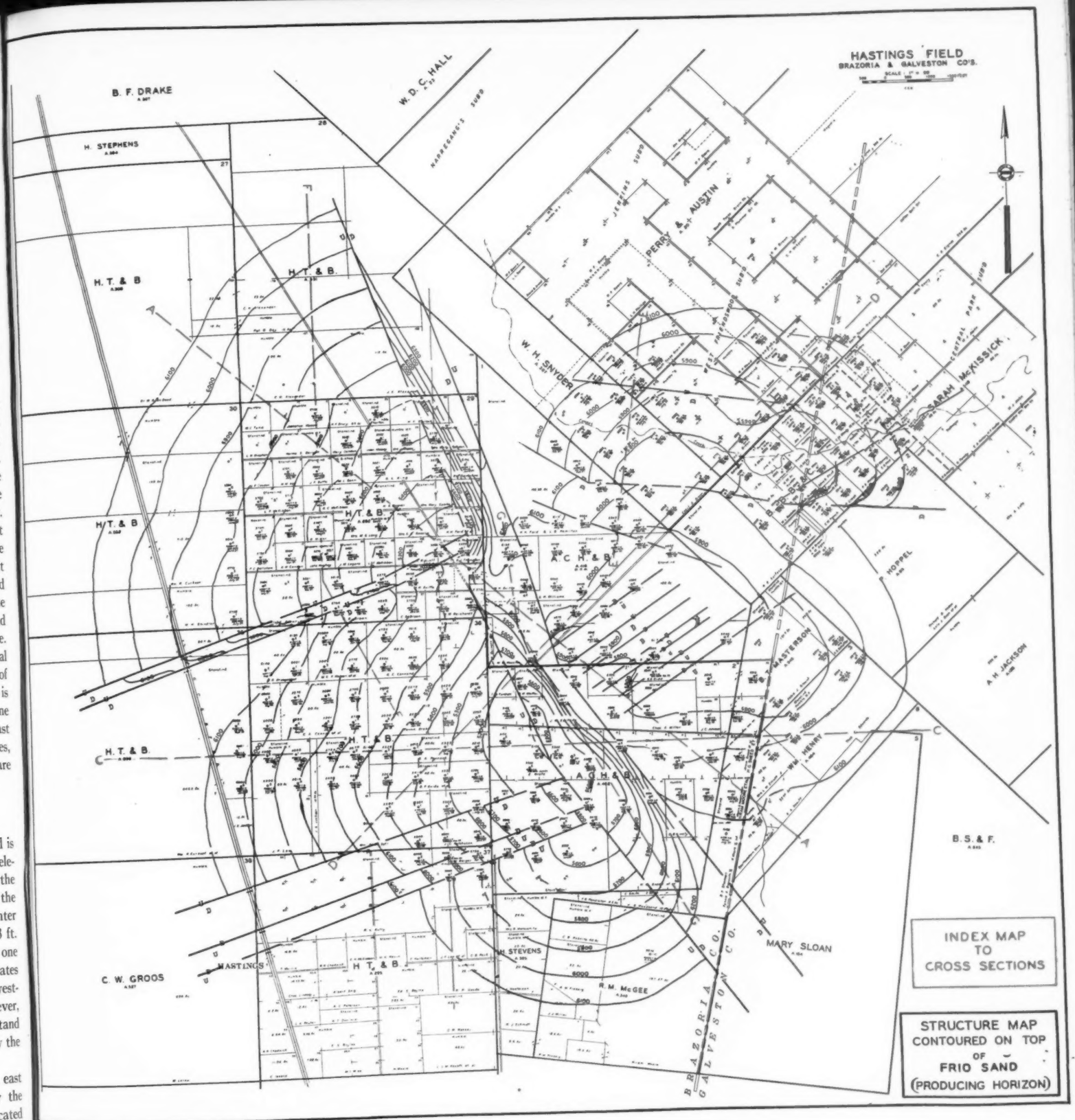
Commission as 10 acres for each well, which means 10 acres to each producing sand. Therefore, Showers and Moncrief were within their rights to produce a No. 2 well on the same 10 acre tract in the upper horizon. This twin well condition will force offset operators to drill another well on each 10 acres in the upper sand as it has been common practice in the past to set the wells and produce them from the lower sand. Therefore, at the present time, the development of Hastings is still in its infancy and a large number of wells will have to be drilled not only to satisfy the twin well ruling, but also to define completely the producing area of the field.

Topographically the field is rather flat with very little difference in elevation throughout the entire area. The soil in places is sandy and in others, black clay. Shell roads were built in the field by the operating companies in order to move equipment more easily during wet weather. Warehouses and storage tanks are kept painted and cleaned regularly, and the locations of the wells after they are brought in as producers are cleaned thoroughly and evenly. Christmas tree connections are the only equipment lying above ground, and each Christmas tree is fenced by pipe. Fire walls are around all tanks, and special earthen pits are dug for the burning of waste oil, which occurs while a new well is being washed-in. The Hastings field is one of the neatest and cleanest of Gulf Coast fields; the old time mud roads, dirty houses, and overhead and on-ground pipe lines are missing.

PHYSIOGRAPHY

The topography of the Hastings Field is rather flat with very little variation in elevation from one part of the field to the other. The normal average elevation in the field is 45 ft. above sea level. In the center of the field the elevation is from 1 to 3 ft. higher than the flanks, and based on one foot surface contours the picture indicates a large flat mound having a northwest-southeast trend. The entire area, however, is so flat in appearance that one can stand on the running board of a car and view the entire field.

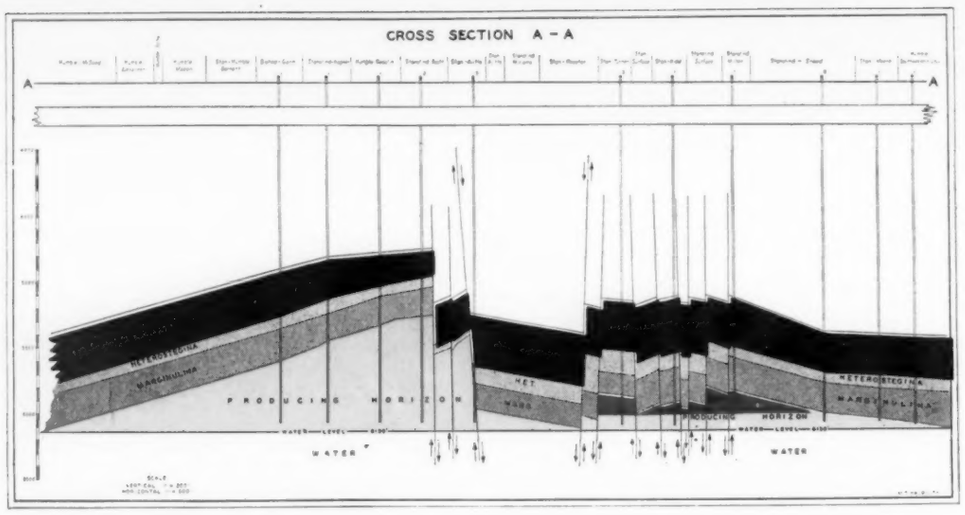
Drainage in the area is toward the east and southeast which is governed by the channel of Cowert Creek, which is located on the east end of the field. Few gullies exist on the south flank. The drainage of these gullies is also toward the southeast. The field is practically barren of trees except to the northeast and east where many deciduous trees are lined on both sides of Cowert Creek. Prairie grass and bushes are the only vegetation in the rest of the field. Such flat and barren ground is very economical from an operating standpoint

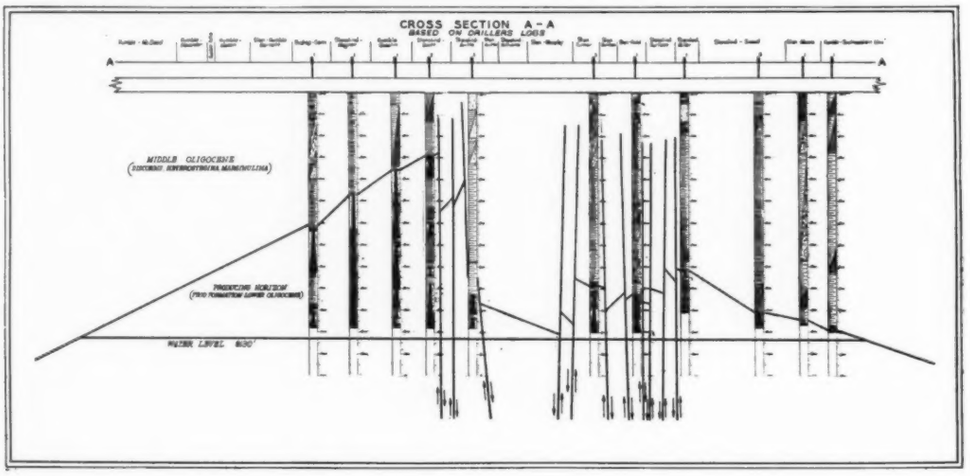


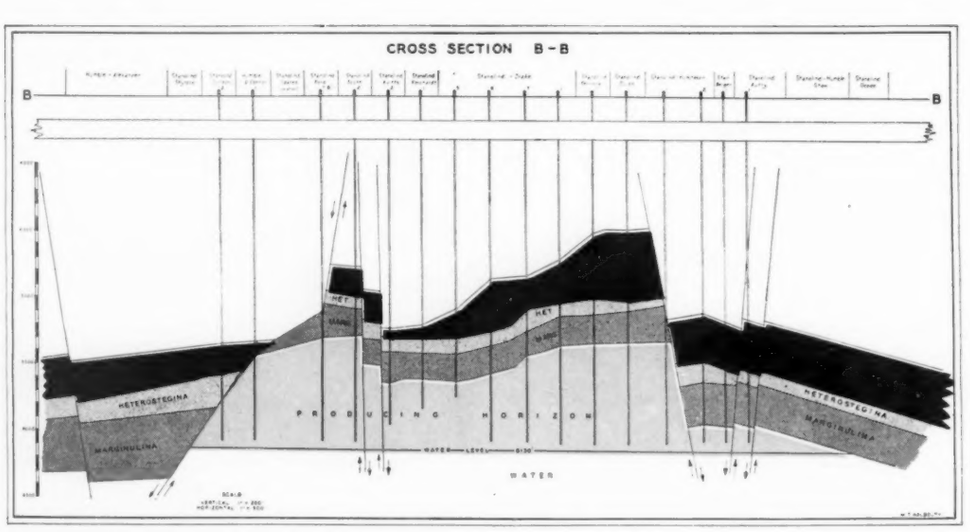
as no clearning of trees is necessary. Locations are made and the equipment moved immediately. In the east and northeast flanks, where the trees are abundant, it is necessary to clear the location of trees and shrubbery, which requires from two to three days before equipment can be moved in after location is made.

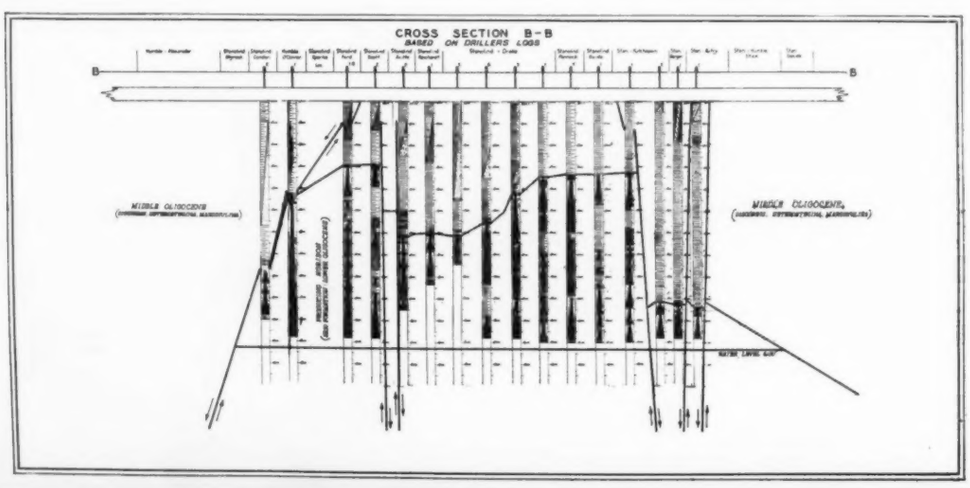
SURFACE GEOLOGY

The Beaumont Clays of Pleistocene Age outcrop on the surface of Hastings and these clays consist of dark gray to black clays and fine buff and sandy loam. In the immediate center of the field the outcropping is of the sandy loam intermingled in spots with the black and gray clays; however, on the flanks of the uplift only the clays outcrop. The buff sandy loam outcropping in the center of the field is undoubtedly the sand layer which lies in and is part of the Beaumont Clays and is found at a depth of 50 to 60 ft. below the top of the clays under normal conditions. In this









case, however, the uplift has probably effected subsequent deposition causing the sand layer to be slightly exposed on the surface, and the regular clays are on the flanks of the field which substantiates the position of the sand. The sandy loam which outcrops at Hastings is also similar to a number of other loamy outcrops in other fields which occur in the Beaumont Clay trend. In dry weather, the loam and clay are very firm and hard and made good ground for transportation of trucks and cars over the field, but in wet weather, the loam becomes sticky, and the clays, slippery and mucky, which makes transportation very difficult. Numerous shell roads have been built around the field which overcomes wet weather difficulties and to date, over 35 miles of shell roads have been built in the field.

STRATIGRAPHY

The Beaumont formation of Pleistocene Age outcrops on the surface at Hastings and ranges downward in thickness from 110 ft. to 170 ft. This formation is composed of gray to black clays with a stratum of buff, coarse to medium grained sand which is found as an outcrop in the center of the field.

The Lissie formation of Pleistocene Age lies immediately below the Beaumont Clays and is easily identified by the first coarse to medium sand break found below the clays. The Lissie is characterized by many water sands, sands and gravels, few boulders intermingled in the sands and shales, and sandy shales. The shales are rather broken and contain many intermingling lenses of sand. The thickness of the Lissie at Hastings ranges from 700 ft. to 800 ft.

The Upper Pliocene formation, which is referred to as the Citronelle, is dominantly calcareous shales and sandy shales, with occasional water sands. The formation is very sandy at the top and gradually becomes shaly as the base is approached. Occasional limestone layers are intermingled in the sandy shales. The thickness of the Citronelle, or Upper Pliocene, is approximately 600 ft.

The Lower Pliocene formation, or Upper Fleming, lies underneath the Citronelle and consists of limestone and sandstone layers interassociated with calcareous shales, sandy shales and sands. This formation is approximately 1,300 ft. thick.

The Upper Pliocene formation, or lower Fleming, is composed of hard, light green to dark green shales, large bodies of sandy shales and numerous limestone layers intermingled with the sandy shales and sands. Sandstone beds are also abundant containing grains held together with a calcareous matrix. These sandstone beds range from fine to coarse grain. The top of this forma-

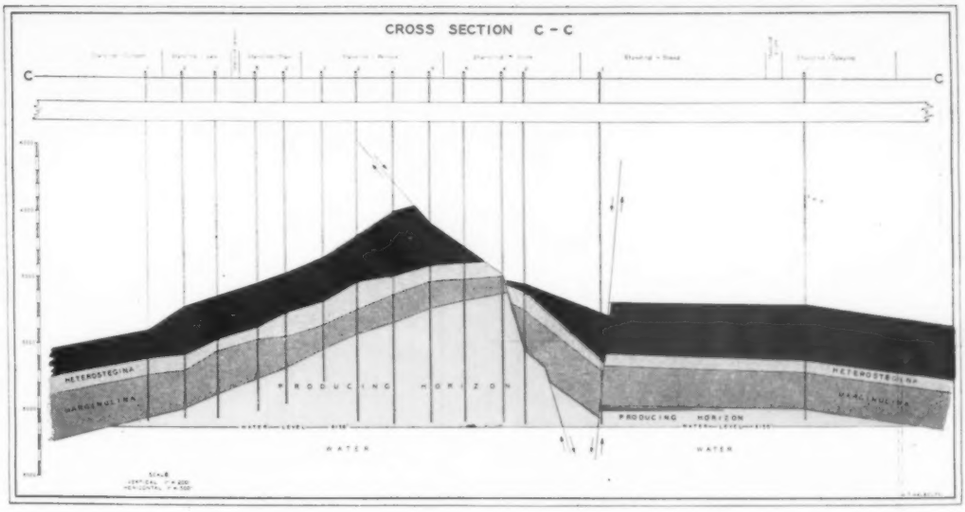
tion is easily identified by the Paleontological guide *Potamides matsoni*, which is placed in the geologic section as being in the extreme top of the Upper Miocene. The top of the Miocene can also be readily identified by the electric logs which clearly show the division of the sandy Lower Pliocene and the sandy and shaly Upper Miocene. The thickness of the Upper Miocene is from 2,000 ft. to 2,500 ft.

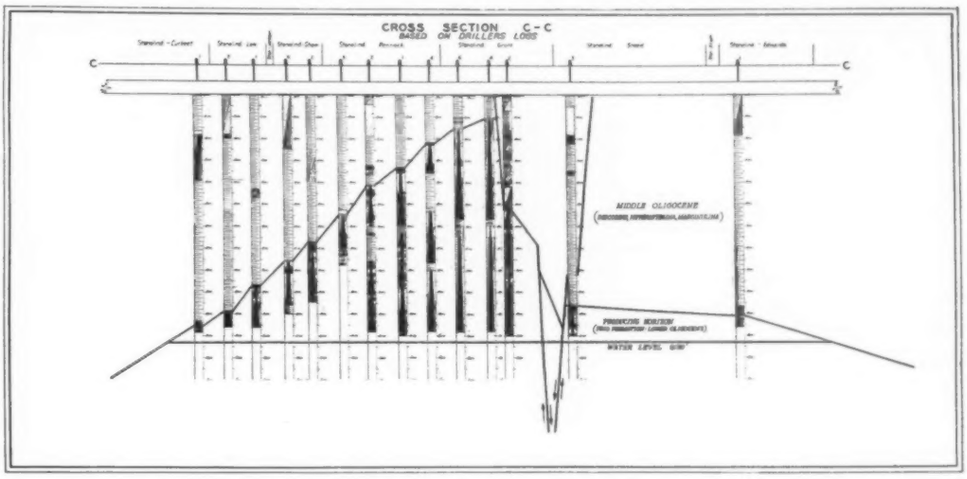
Underlying the Upper Miocene is a zone composed of sandy shales and sands which range in thickness from 50 ft. to 100 ft. This zone is characterized by the appearance of *Discorbis* cf. D. *vilardeboana* D'Orbigny and its associated fauna with *Rotalia beccarii*, (Linne) D'Orbigny and its associated fauna. The latter *Foraminifera* are the guide fossils for the Miocene formation and the *Discorbis foraminifera* are the guides for the *Discorbis Zone: Middle Oligocene*, and as this zone marks a period of transition between the *Discorbis Zone* and the Miocene formation, the zone was called *MDv Zone*, as *MDv* was considered being symbolic for Miocene formation and *Discorbis Zone* characteristics, paleontologically. This zone was first named and described by the writer. Figure 2 in May, 1936.

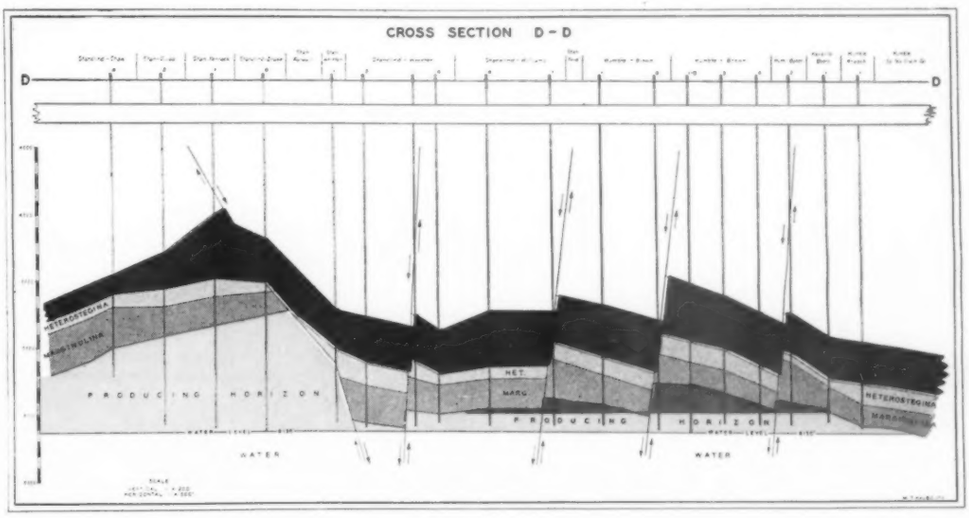
Underlying the *MDv Zone* is the true *Discorbis Zone* of Middle Oligocene Age. The *Rotalia beccarii* that are associated with the *Discorbis* fauna in the *MDv Zone* passes out of the section and the true *Discorbis* cf. D. *vilardeboana* becomes large and prominent, which marks the top of the *Discorbis Zone*. This zone is characterized by shales and layers of sandy shale. The thickness of this zone is from 170 to 450 ft. This variation in thickness is due to faulting in the field which faults out and pinches out the zone in many wells.

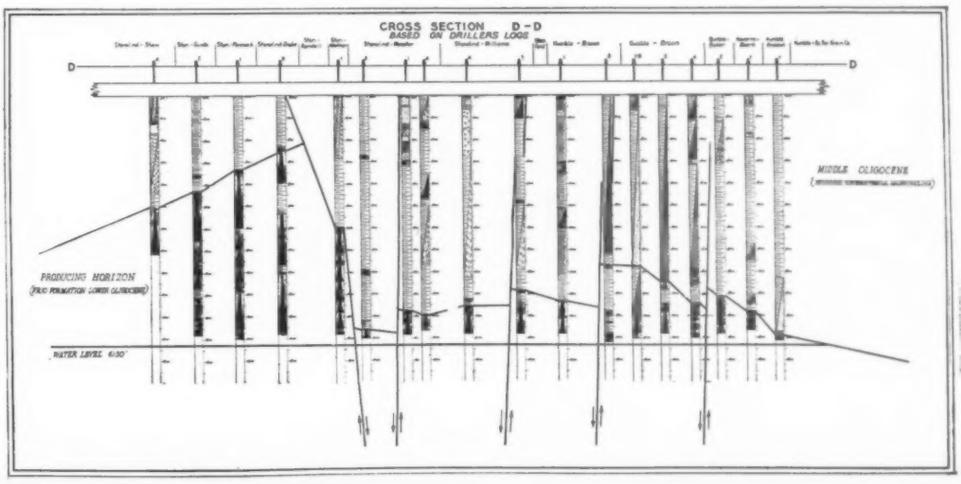
Underlying the *Discorbis Zone* is the *Heterostegina Zone*, which is the middle member of the Middle Oligocene formation. This zone is distinguished paleontologically by the appearance of *Heterostegina antillia foraminifera* and associated fauna. The zone consists of hard calcareous shales with lime streaks. No sands occur in this zone and very little sandy shale. The zone ranges from 110 ft. to 190 ft. in thickness.

Underneath the *Heterostegina Zone* is the lower member of the Middle Oligocene formation, which is the *Marginulina Zone*, so-named, and paleontologically identified by the so-termed *Marginulina* cf. M. *phillipensis foraminifera* found in the zone. The *Marginulina Zone* is composed of dark greenish gray calcareous shale. No sands and very little sandy shale is found in this zone. The thickness ranges

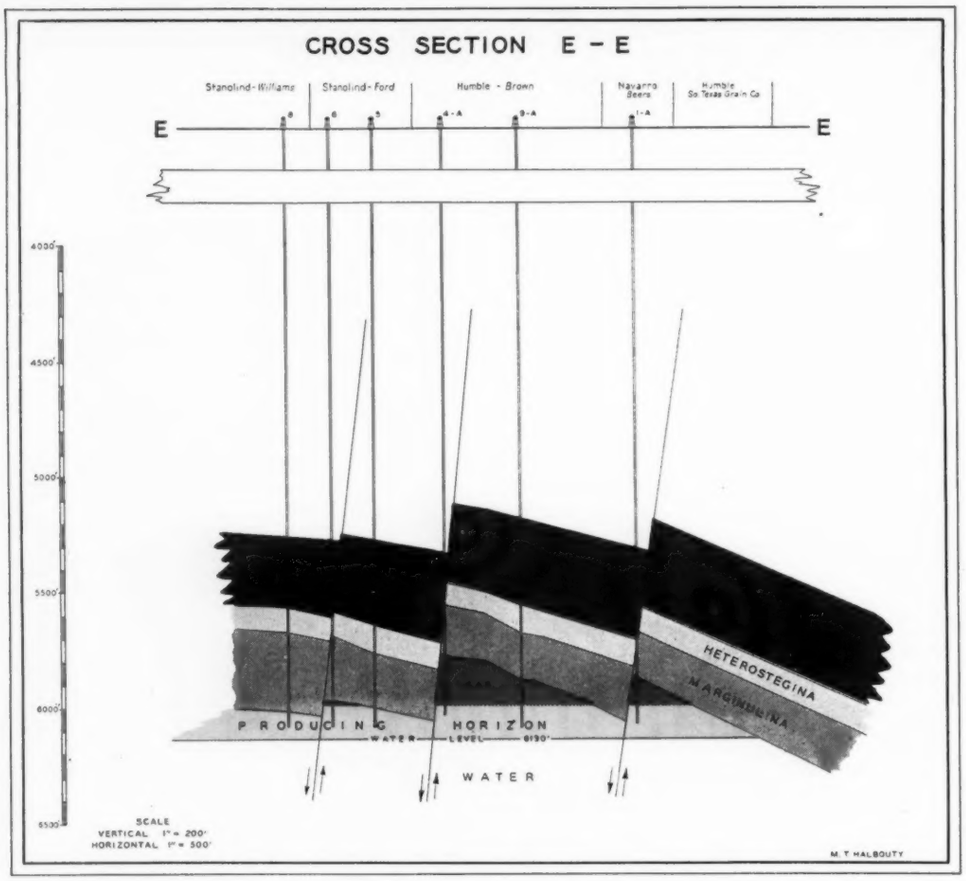


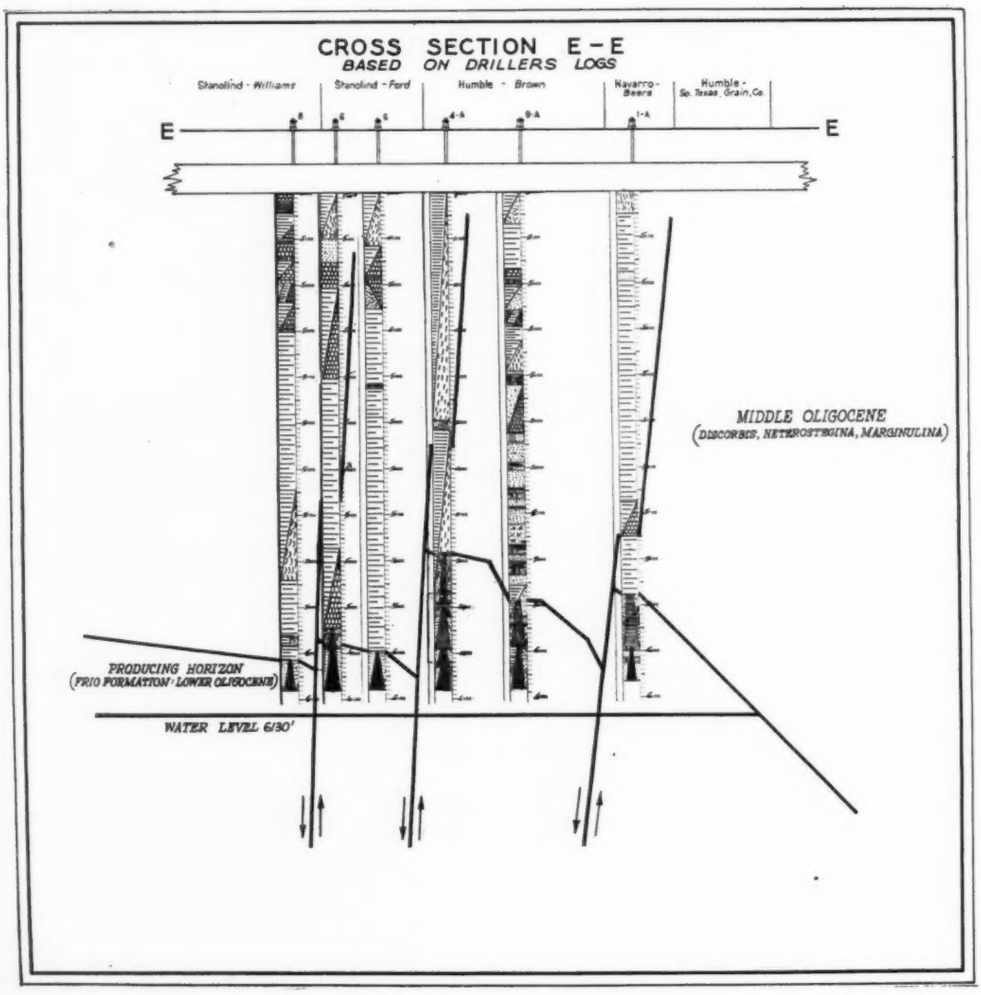






[2] M. T. Halbouty, "Geology and Geophysics showing Caprock and Salt Overhang of High Island Dome, Galveston County, Texas." Bull. Amer. Assoc. of Pet. Geol. Vol. 20, No. 5, May, 1936, pp. 568-570.





from 230 ft. to 470 ft., such variation effected by the faulting in the field.

The Frio formation of Lower Oligocene Age lies underneath the *Marginulina Zone* of Middle Oligocene Age. The Frio formation at Hastings consists dominantly of sands and is the producing formation in the field. The producing horizon in this field has one of the finest and most prolific sand sections in the Gulf Coast and the maximum thickness of this producing horizon above water level is 1,025 ft. The sand section is not consistent in the producing area as many shale breaks are found between sands carrying oil. However, approximately 50 to 80 percent of the producing section consists of sand carrying oil and gas. The sand is fairly coarse grain, requiring a .010 gauge screen. The shale which occurs in the Frio producing section is intermingled with the sands in small thin layers and also in occasional continuous layers ranging from 75 ft. to 150 ft. which divides the upper sand from the lower sand. The producing horizon is not consistent throughout the field in its lithological and physical characteristics which makes the drilling of each well an individual problem. For instance, in some parts of the field (as will be thoroughly explained later in this report) there is a gas cap above the oil sand and in other parts of the field this gas cap is absent. Wherever the gas cap occurs, the gas-oil contact is at 5,990 ft. The oil sand in some places is very firm and well consolidated but not indurated, and in other parts of the field the sand is extremely soft. The producing sand as a whole could not be described as one having the same physical characteristics throughout the field, as these characteristics change from one section to the other. For instance, the very soft unconsolidated sands have a high percentage of pore spaces or porosity, whereas the firm consolidated sands have a lower porosity. Nevertheless, the average porosity for the entire producing sand section can conservatively be estimated at 30 percent. The oil saturation in the sand also varies, with greater saturation being prevalent in the soft porous sands. In the area to the west of the central graben the sands, as a general rule, are rather soft and contain a high percentage of saturation and porosity and in the area east of the graben the sands are firm, as a general rule, and consequently contain a lower saturation and porosity as compared to the western area. In some wells there have been sands in both areas which are in exception to the general trend of the respective sand characteristics of each area. The average oil saturation of the entire field is conservatively estimated to be 80 percent of the effective pore spaces of the sands. Intermingling shales and difference

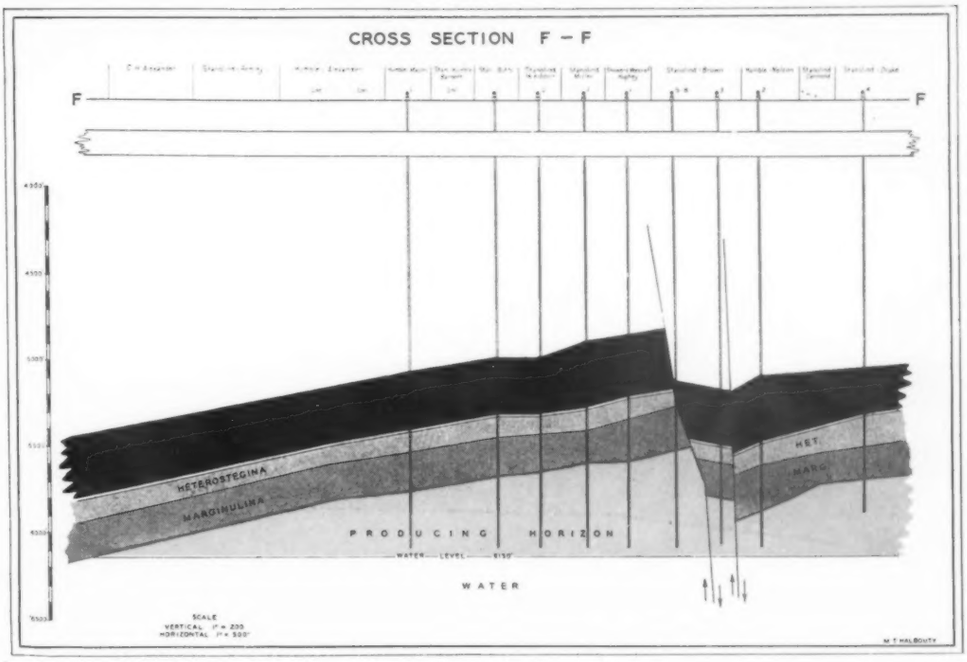
in physical characteristics alter the figure from lease to lease, but the above figures are good conservative averages.

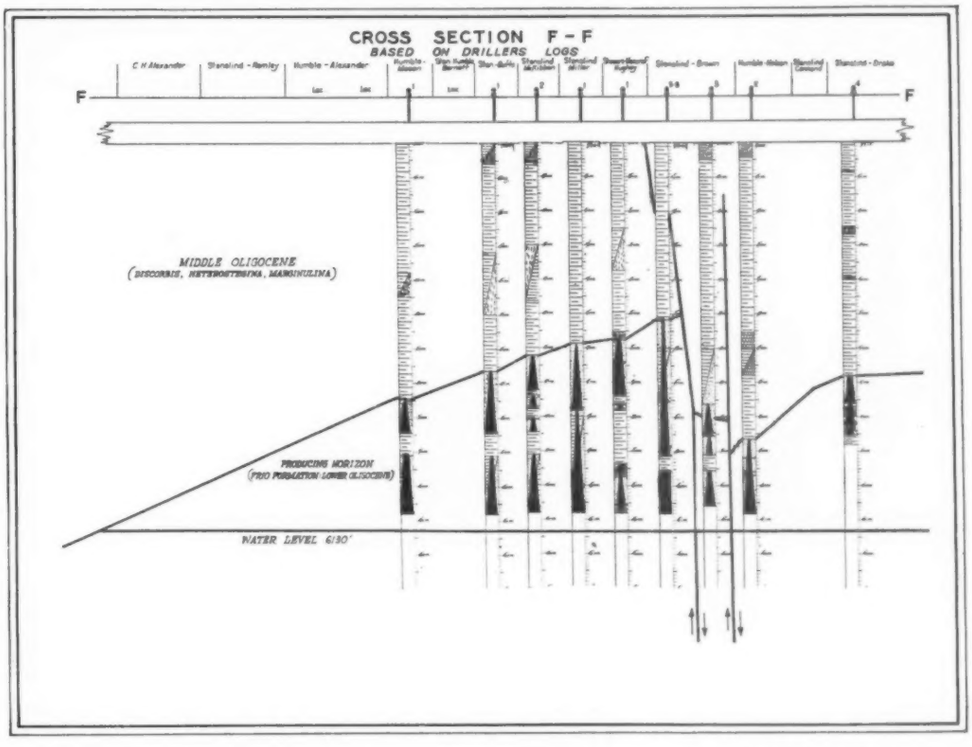
The gravity of the oil produced ranges from 28 deg. to 31 deg. A.P.I. The average gas-oil ratio per well is 1,100 cu. ft. of gas to one barrel of oil. The wells come in flowing with an average initial tubing pressure of 1,000 lbs. per sq. in. and with an average potential production of 590 bbl. of oil flowing through a ¼ in. positive choke per 24 hours.

SUBSURFACE GEOLOGY

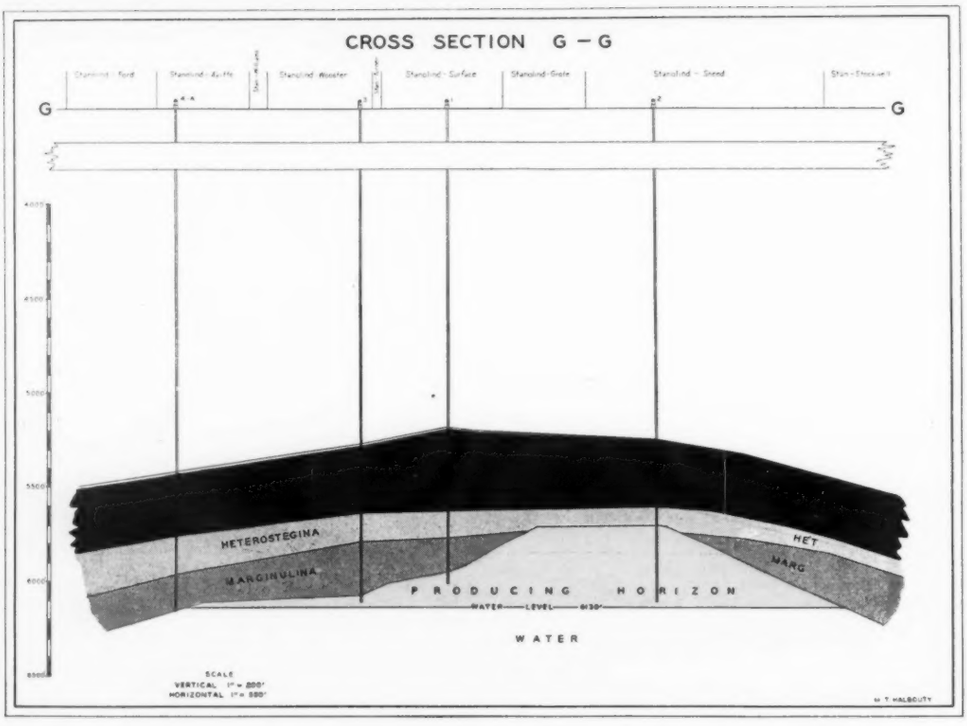
The Hastings oil field is considered to be a deep seated salt dome structure, with the curvatures of the formations forming a regular dipping pattern, marked and broken by many faults. This structure is similar to the Anahuac field of Chambers County, Texas, which was described in this publication last April. The maximum uplift of the Hastings structure is 1,025 ft. above normal. This maximum uplift is equal to the maximum amount of producing section present in the field. The field lies in a very prolific producing trend in the Gulf Coast and is considered to be located on a geological "high" or geophysical "minimum" that extends from the Genoa area, through the new Friendswood discovery, thence through Hastings, and which finally includes Manvel before dipping off into normal again. In other words, Genoa, Friendswood, Hastings and Manvel are all structures on a subsurface geological "trend high" and geophysical "minimum" which in itself is one big structure. Of the four areas, all are producing and proven areas except Genoa. Genoa has not yet been drilled, however, it is regarded as having good possibilities. Manvel is at the northwest end of the "minimum" and Genoa at the northeast end, and Hastings is in the middle and to the south of both of these ends, forming a u-shaped pattern. Between each producing field there is a dry area which has either been created by faulting or rim synclines. At Friendswood it is considered that faulting separates the new discovery from the Hastings field and a rim syncline formed by the two uplifts of Manvel and Hastings separates these two areas. Figuratively speaking, this elongated trend can be referred to as a minor Gulf Coast anticlinorium, with "highs" and "lows" on a "high."

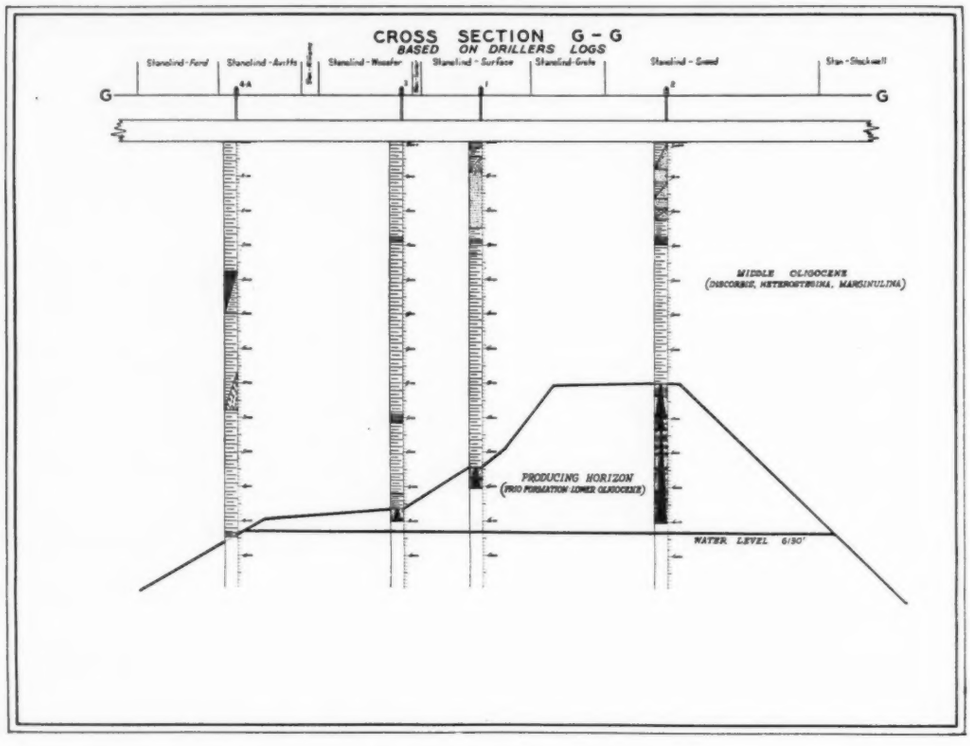
By studying the Sand Contour Map, page 39, one readily observes th at the field has many faults and is broken-up by these faults in a most uniform manner. The large feature on this map is the central graben which runs through the field in a northwest-southeast trend. This graben, as later will be brought out, has played an extremely important part in the production as well as structure of the dome. As in most Gulf Coast fields, there are two systems of faults, one runs northwest-southeast and the other northeast-southwest. The northwest-southeast system is the major of the two and the northeast-southwest system is composed of small faults which run practically perpendicular to the northwest-southeast fault system. The large faults occurred first during uplift and the smaller faults were vents for the relief of tension and compression which gave way at right angles to the major faulting.





The uplift history of this dome is a rather interesting one and should be summarized before the structure is further considered in this report. The single uplift of Hastings began on a very small scale as it was part of a still larger uplift and consequently the area "rode" on the movement of the major uplift. Later the movements began to become localized which ultimately caused such singular uplifts as Manvel, and when localized movement began in this subsurface arch, the area at Hastings also began to become a singular feature. The pressure



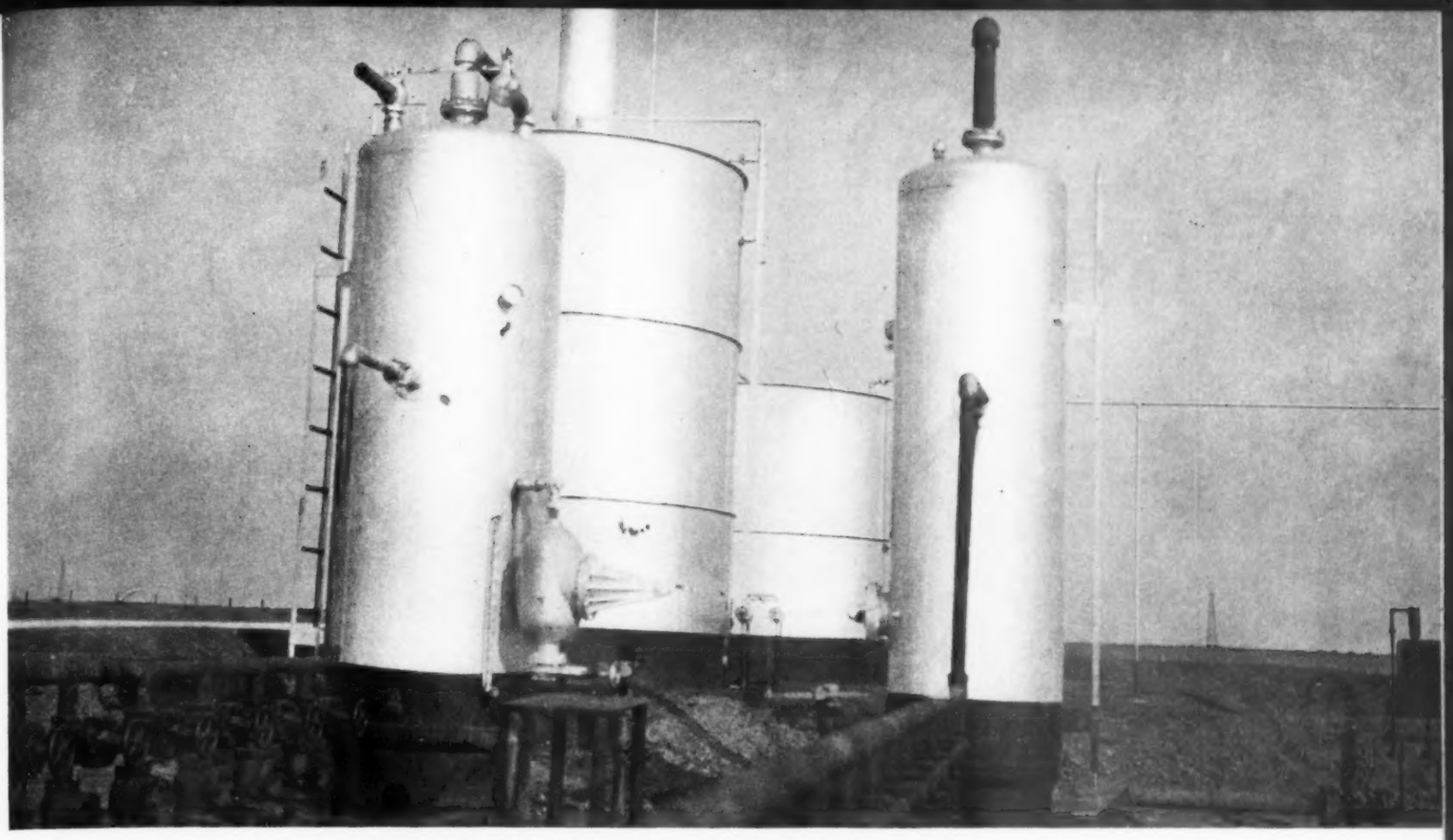


below caused the Hastings area to become arched in a most gentle anticline covering a much larger area than the field does today, and it was during and after this gentle anticline was formed that oil and gas began to migrate in the anticline. It is the author's belief that lateral instead of vertical migration took place on this original oil movement into the area. Movements gradually progressed and the uplift by stages became higher and more arched until, in order to relieve the pressure and tension, faulting occurred. Still later, more faulting occurred, such movements taking place as late as late Miocene times and probably later. It was during these stages of faulting that such oil migration from one side of the structure to the other occurred. This faulting also accounted for the absence of a gas cap in the structurally higher area.

The gas-oil level is established in the field as being at a depth of 5,990 ft., but this level only holds true in the area east of the central graben. In other words, there is no gas cap in the area west of the central graben. The producing section west of the graben is strictly an oil horizon and the section is thicker and higher by several hundred feet than the producing section east of the graben. The presence of gas in the lower area and not in the higher area is rather an unusual one for Gulf Coast fields, as it is customary for the gas cap to be present in the entire field above the gas-oil level, such as the Anahuac field in Chambers County, Texas.

The accumulation of the gas in a restricted area at Hastings can be hypothesized as being due to progressive movements of the uplift. This restricted accumulation of gas is described below.

The Hastings structure is considered to be directly caused by the uplift of a deep seated dome and the movement of uplift was in progressive stages taking a long period of time finally to relieve all tensional and compressional forces which ultimately arranged the structure as it is today. Therefore, during some early stage of uplift when the pressures were only sufficient to arch the area into a gradual dipping anticline, the oil migrated into the sands and was trapped according to the law based on the anticlinal theory of accumulation: that is, gas on top, oil underneath, and water below the oil. After this migration and accumulation, successive stages of the uplift occurred with such pressures as to cause considerable faulting and these faults had a decided bearing on the further migration and accumulation of oil from the already prolific sand bodies which trapped the oil in its early stages of uplift. The area designated as being west of the central graben probably was in the oil horizon of the primary uplift and not high enough to trap the gas. Now later movement caused faulting which threw the west area higher than the east area and separated the two by the graben. The faults of the graben are so structurally formed as to connect the producing sand horizon by series of steps, the west step, or area, being the highest. This connection of the sands in the downthrow side of the faults is also low enough to be only in the oil horizon and not in the gas horizon also. Therefore, after these later movements and structural arrangements, the oil from the original trapping beds migrated by this series of steps from the lower east area into the higher west area, and only oil migrated *without the migration of gas*, as the gas horizon was too high above the connecting point of the faulted sand bodies. The only decided change in the new accumulation and migration was that of the water level



Complete battery of tanks and separators in the Hastings Field, Texas.

which moved upward as the oil was migrating into the area to the west of the central graben. Therefore, when movement ceased entirely and the final accumulation was stationary, only oil and water were found without the gas cap on the high western side of the graben, and gas, oil and water were found on the lower east side of the graben, which area was the original trap for the original accumulation of gas, oil and water, respectively.

It is also evident that the original top of the dome was centered in the southwest corner of the Wm. Snyder Survey, located in the northeast side of the field. In this area the thickness of the gas sand is at its maximum. In the early stages of the movement of the field, which formed the gentle dipping anticline in which gas, oil and water accumulated, the gas centered in its greatest quantity in the apex of the dome which, at the present, is ascertained to be in the area before mentioned which is proven by the maximum thickness of gas sand as found by the drill, and which has been retained there by southwest and northeast dip toward the east fault of the graben.

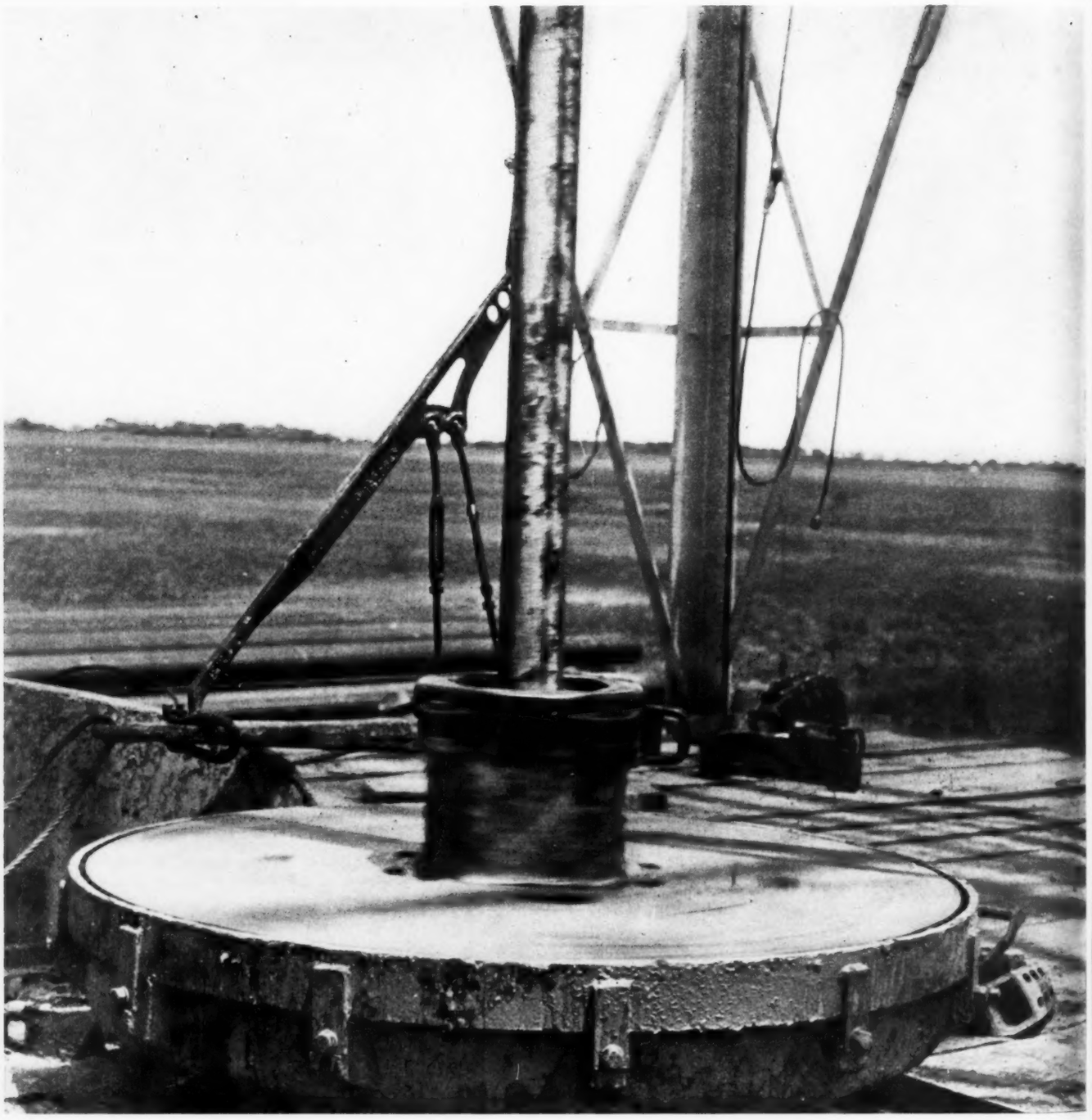
It is also evident that the main west fault of the graben elevated a portion of the original southwest, west and northwest flanks of the dome because had the fault been located farther to the east and northeast and had it cut through the gas area at the apex of the dome, the gas would have migrated to the upthrown west side of the fault which would have been the higher area and consequently a gas cap would have been present in that area also. As explained above, however, in the area west of the main west fault of the central graben, the gas is absent as a separate cap and exists only in solution with the oil.

This difference in elevation of the producing horizon on the west and east sides has greatly reduced the original area of accumulation by over one-third of the present producing acreage. There is no doubt that had not this fault uplift occurred on the west flank of the original dome, the field would today extend over a larger area.

In the area to the west of the graben the top of the producing horizon is found as high as 5,105 ft., whereas the highest point of the horizon to the east of the graben is at 5,748 ft. Over 600 ft. more of producing horizon existing to the west is sufficient alone to make that side the most prolific, important, and desired side of the field.

It is well to state at this time the relationship and significance of the gas that is found in a restricted area in the upper sand of the Miocene formation. This area is affected by faults and these faults have a decided bearing on the accumulation of gas into the Miocene sand. This sand is at 2,900 ft. and is referred to as "2900-ft. sand." The 2900-ft. gas sand is considered to be Upper Miocene in age, being part of the *Potamides matsoni Zone* which is the uppermost zone in the Miocene formation. This zone is very sandy and contains a number of sand bodies. Not all of them, however, are saturated with gas and those that do have gas are situated in a restricted part of the field. This so-called restricted part is found in the A. C. H. & B. Survey, Section 2, localized mostly in the Grote lease. One well is producing from this gas sand, namely, Stanolind Oil and Gas Company's E. Grote No. 3, which was completed as a gas well solely for furnishing fuel for the company's operations in the field. This well, bottomed at 2,960 ft., had 60 ft. of gas sand and was completed for an initial production of 15,000,000 cu. ft. of gas daily with a rock pressure of 1,040 lbs. to the sq. in. This well is located in the central graben and the presence of the gas at such a shallow level can be deducted as being due to the escape of gas from the lower producing horizon along seepage channels formed by the nearby faulting. This migration is a perfect example of vertical migration in a local structure.

Such an occurrence would depend entirely on the arrangements of the faults in the area and the broken formations caused by these faults. The seepage channels would be entirely governed by the interassociation of one broken stratum to the other and the rate and quantity of vertical migration would depend on the porosity and permeability of the original reservoir and of the subsequent horizons that the gas migrates through in its course to its final trap. It is highly possible that after the faults of the central graben formed, which threw the inside Frio sand too low to catch any migrating gas, this gas could have migrated up the broken fault plane of the east fault of the graben to the upper



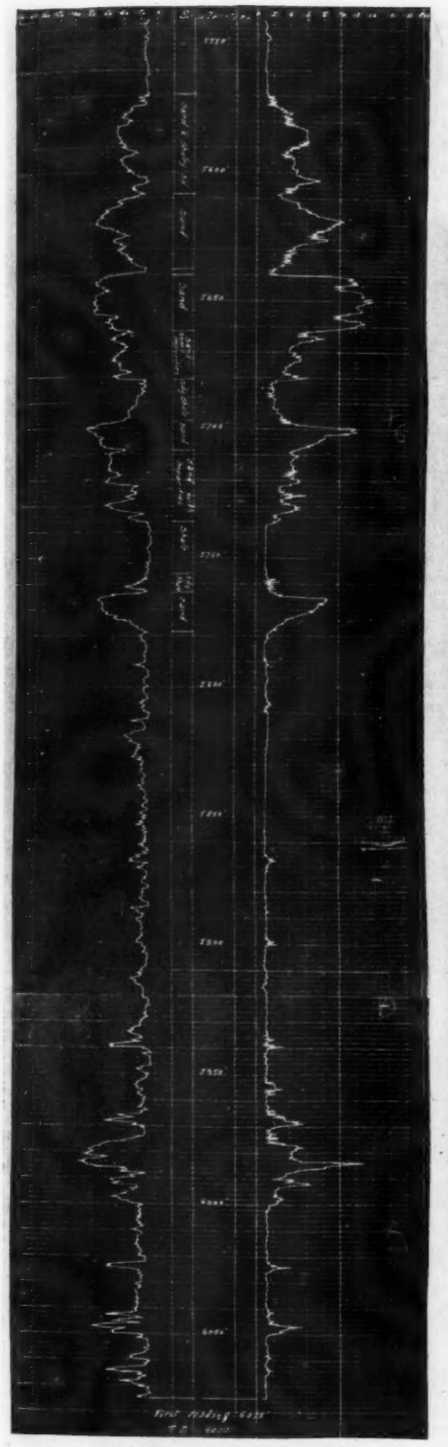
Rotary in action at Hastings: note flat, treeless field in background.

sands before an outlet and trap was found. If this is true, vertical migration of gas to one source and separate vertical migration of oil to another took place at or near the same time.

The Contour Map on page 39 is based on the top of the producing horizon, or first sand in the Frio formation. On this map is also shown the top of the sand in each well: the figures are shown above the location for each well. The total depth, initial production, and month of completion of each well is also shown below the location of each well.

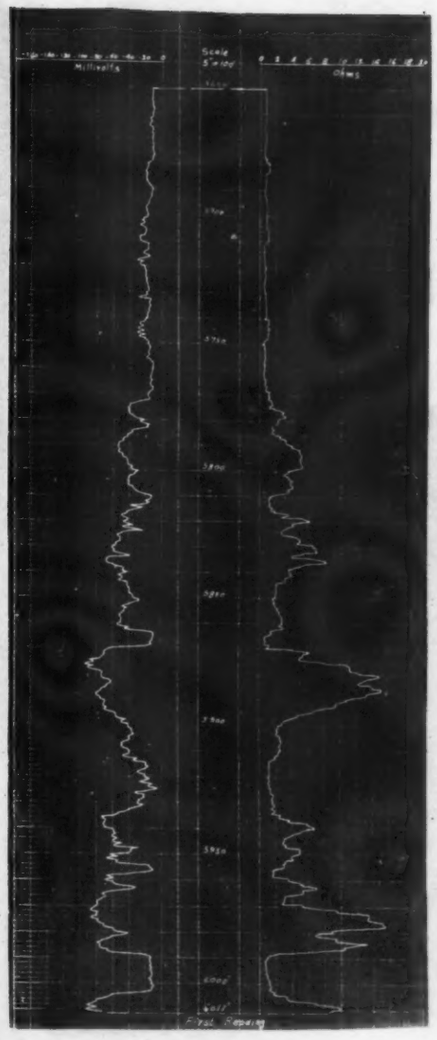
Six cross-sections are drawn to illustrate positions of faults, formations and producing horizons in the field. Cross-section A-A cuts across the prolific northwest side of the field and cuts across the majority of the faults in the field. These faults are shown as step-faults, however, an occasional horst and graben are found which balances the fault system in accordance to the formational dips off the flanks of the field. Cross-section B-B is of the west end of the field so drawn as to include the three sections which are divided by faults; namely, the east end of the northwest section, the western central section, and the southwest section. The two groups of parallel faults separate these sections. The producing horizon and position of the zones of the Middle Oligocene formation are clearly

ELECTRIC LOGS OF PRODUCING SECTION IN HASTINGS FIELD



Top of Oil Sand 5575'

Showers & Moncrief – Leta Hughey Nº 1

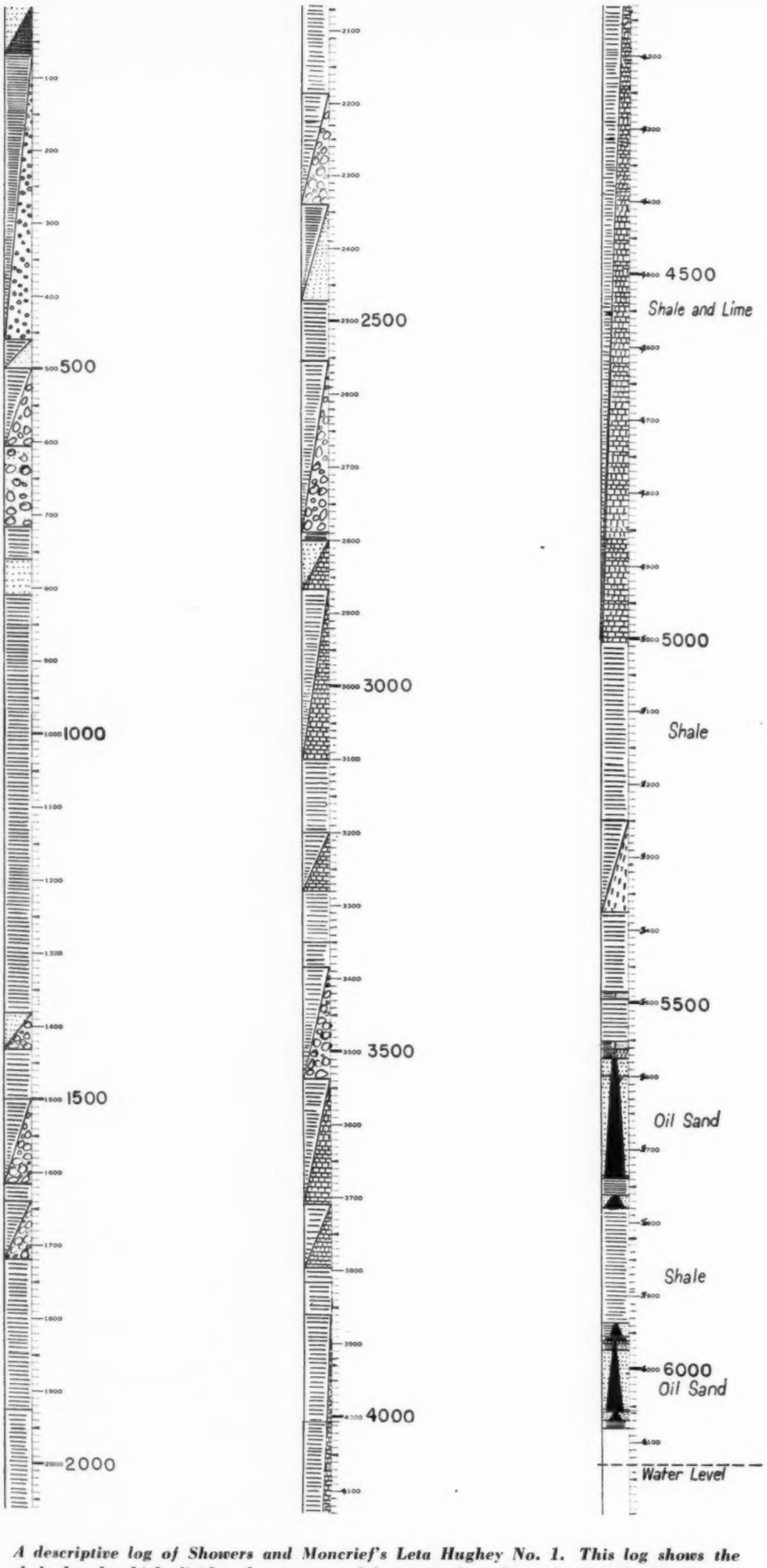


Top of Oil Sand 5772'

Humble – Nelson Nº 1

Top of Gas Sand 5840'
Top of Oil Sand 5990'
Goldston Fee Nº 2

Electric logs of the producing horizons in three Hastings' wells. Note the variation of electrical characteristics in the sands.



A descriptive log of Showers and Moncrief's Leta Hughey No. 1. This log shows the shale break which divides the upper and lower sands. Compare this descriptive log with the electric log of the same well on page 47.

shown. The graben is also shown to the extreme north end of the section which illustrates the throw of the downthrow side. It is to be noticed that the sand has been thrown into the water level. The wide angle of hade of the west fault is also shown.

This wide angle of hade on the western fault of the central graben is clearly borne out by Cross-section C-C which is drawn from west to east across the field. The thickness of the producing horizon in the west side and east side can easily be compared in this cross-section. In Section A-A the gas sand is also shown in a larger thickness than that shown in Cross-section C-C.

Cross-section D-D also shows the difference in the two sides of the field and also shows the maximum amount of gas sand found in the field.

Cross-section E-E is made through the extreme northeastern part of the field which shows the relationship of the faults in that area to production and the abrupt dip that the producing horizon has in falling off into the water level. It is probable that more faulting may be found to the northeast of the farthest fault in this cross-section, and if so, it may have an effect on probable production and extension of the field. The abrupt dip is not characteristic of the general dips off the flanks of the field, and this particular dip may be due to unknown faulting.

Cross-section F-F is taken from the northwest portion of the field and is drawn to show the possible area that may produce north of the proven acreage. The section also shows the producing horizons on both sides of the faults which divides the western, northwest section from the western, central section.

Cross-section G-G is drawn lengthwise to the elongation of the graben. This section shows the structure of the graben and its effect on production. The dry hole, Stanolind Oil & Gas Company's Avitte A-4, is interesting from a structural standpoint as it shows the eccentric structure of the graben and by referring to the structural sand contour map, an idea of the limits of production in the graben can be ascertained.

Below each drafted cross-section is the same section based on drillers' well logs. These logs are far from being accurate but they were used in order to furnish some idea about breaks of shale in the producing horizon and the amount of sand that was shown to be present in the section by the feel of the drill. These logs were very helpful in determining the division of the upper and lower sand by the shale break between the two sand horizons. This upper and lower sand is only evident in wells to the west of the central graben. The oil and gas contact of 5,990 ft. in the area east of the central graben and the limited amount

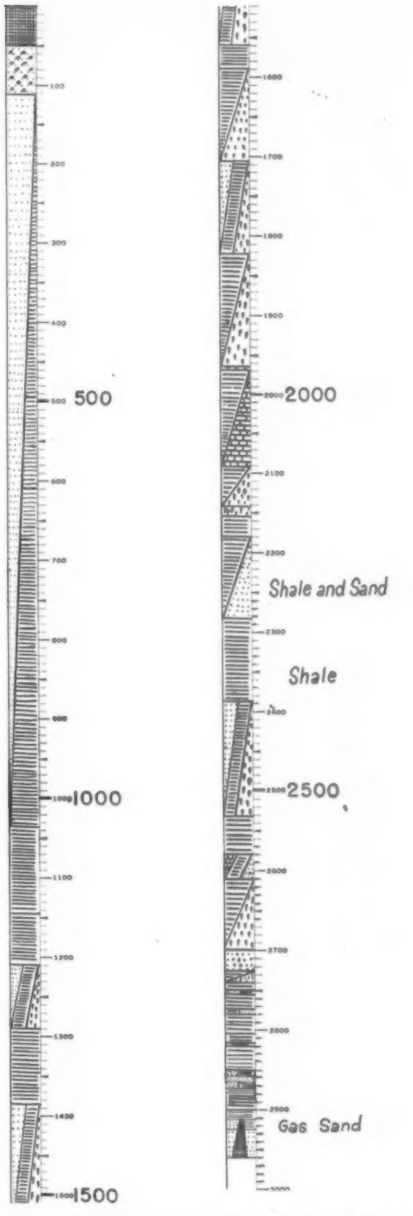
of oil horizon indicates no need for twin wells in that area. However, in the area to the west of the central graben where a maximum of over 1,000 ft. of producing horizon is present, and the sands are separated by distinct shale breaks, the twin well situation, or a well in each sand, is warranted. The operating program at present calls for these twin wells in the area west of the central graben.

By referring to the drillers' logs in the cross-sections, it is noticed that the first sand is identified as being that sand above the shaly section near 5,900 ft. and the lower sand below this shale break. The upper sand is referred to as the 5,800-ft. sand and the lower as the 6,000-ft. sand. The majority of the twin wells will be set at a depth of about 5,800 ft. and that is why the sand is referred to by that depth. The electric logs show the division of these two bodies much clearer than the drillers' logs. Page 47 shows the electric logs on several wells in the field and the log to the left of the figure shows the two sands separated by shale. This shale break as shown in this well is the maximum amount of continuous shale found in one break in the field. Note the difference of the sand section in the log on page 50. This latter log shows over 75 percent sand in one 500 ft. of section, whereas in the log on page 47 the sand is only 50 percent in about the same thickness of section.

PRODUCTION METHODS

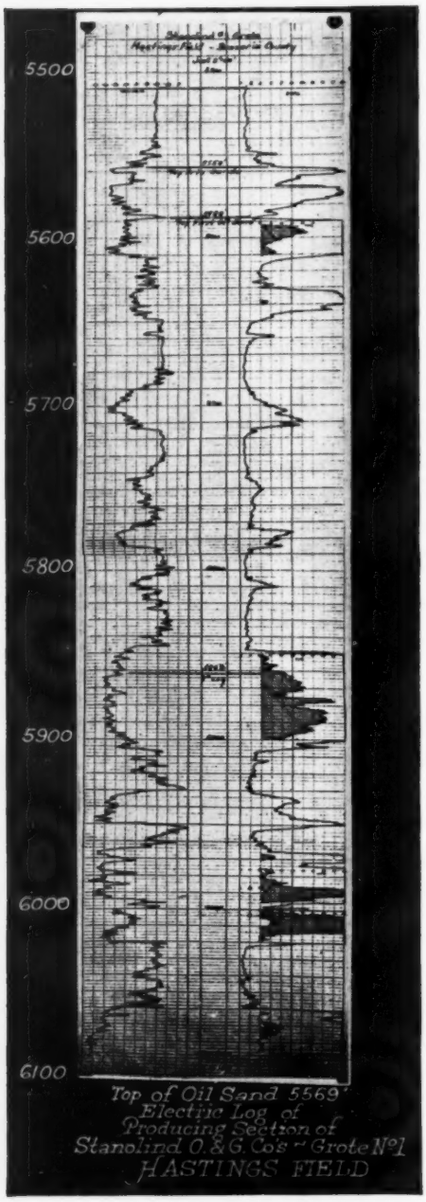
Production methods at Hastings are similar to those used in other developing fields where major companies operate. At Hastings there are only two major operators: The Stanolind Oil & Gas Company and the Humble Oil & Refining Company. The independents are Walter Goldston and Showers and Moncrief. Hastings is considered as being one of the very few major Gulf Coast fields where independents do not have a substantial amount of proven acreage. The Stanolind Company has 16 rigs running in the field and the Humble Company has six rigs. The independents have drilled their acreage up and at present are not drilling. A total of 22 rigs in the field makes it one of the most active fields in the Gulf Coast territory. With the advent of a twin well program, it is possible that the total number of rigs running in the field may easily exceed 35.

Operations are speeded considerably by quick methods of moving in on locations and the flat, practically barren terrain that is present in the field. Except for the extreme northeast flank, no clearing of location is necessary and equipment can be moved in at once after location is made. Future locations are always staked out and the slush pits, derrick, pipe racks, surface pipe and "long string" laid on pipe racks, and roads are all built and moved in on location, which awaits only the moving in of the rig equipment to start actual drilling operations. If a well is completed on one particular day, the rig is moved over to the next prepared location and is spudded-in by the next day. With the trucking and drag lines available the rig is moved and set up in less than 24 hours and the drill-pipe rotating and making hole by the end of the 24th hour after the first piece of equipment was moved from the completed well. Drilling conditions are almost ideal at Hastings with no hard formation digging and the average time for completing a well into the tanks from the spudding date is 15 days. Considering the wells to be at depths of approximately 6,080 ft., this time is unusually fast for the Gulf Coast. Approximately 800 ft. of hole is made per day, and counting cementing time for the surface and long strings, the well is completed in 15 days. Procedure in drilling is based upon a conservative basis in the following manner. As stated above, the derrick, etc., is all ready for the rig to be moved on the location which takes about 24 hours to rig-up the equipment in such a manner as to begin actual drilling. Many minor features are not rigged-up in this initial operation as it does not become necessary until after surface casing is set. The Stanolind Company and Humble Company do not use the same casing program in the drilling of their wells. The Stanolind's procedure will first be discussed. In the drilling of the discovery well, the Stanolind set 20 ft. of 20 in. conductor pipe, and over 1,100 ft. of 13⅜ in. O. D. surface pipe was set and cemented. The producing string was 9⅞ in. O. D. and 5,975 ft. was set and cemented. For a liner 7 in. O. D. pipe was set with the screen for a production test. Later the company changed to setting about 90 ft. of 16 in. conductor pipe, 10¾ in. O. D. surface casing, 7 in. O. D. on the long string and using 5½ in. O. D. for liner. The Humble Company does not set any conductor pipe and uses 9⅞ in. O. D. casing for the surface string and 5½ in. O. D. casing for the long string. The Humble method is more economical and serves the purpose just as well. The Humble Company has used a similar casing program in many of their fields and has saved a considerable amount of time and money in these operations. Regardless of what casing program is used, the drilling operations are rather similar. The surface casing is cemented with 300 to 400 sacks of cement and allowed to set for 48 hours. During the time allowed for the cement to set the rest of the equipment which was not rigged-up in the initial operations is completed and the



Descriptive log of Stanolind's Emil Grote No. 3. This well is producing gas from the Upper Miocene sand at 2,900 ft.

rig is put in first-class shape to begin digging the lower hole. Operations are then started and the hole is made with good 9.6 to 9.7 pound mud which is relatively low in sand content, and has a viscosity A.P.I. funnel measurement of 36 to 38 seconds. Blow-out drills are conducted with every crew and precautions are maintained to prevent blow-outs during drilling of the well. The cuttings of the drilled hole are caught and paleontological determinations are made on them by the field paleontologist, who by his knowledge of other wells already completed, gives the coring depth. On a relatively high well and where gas sand is expected, coring would begin at



Electric log of Stanolind's Emil Grote No. 1. This log shows over 75 percent of the section to be sand.

approximately 5,990 ft. which is the oil and gas contact. If the well is running low, the well is cored from the corresponding depth difference in the height of the well. On the high wells where a full oil section is present, the coring is continued to about 6,080 ft., and on low wells as much as 5 to 15 ft. of oil sand would be sufficient. The coring is done by the wire-line method, in which a core barrel assembly with a catching latch on top of the core barrel is dropped into the drill pipe while the pipe is in the hole, and after a few minutes the barrel fits snugly into a hole in the core-head-bit at the bottom of the hole. The barrel is pumped down the pipe, and after it is in place, the core is cut and the barrel is ready to be pulled. An overshot fishing tool, especially made for catching the latch on the core-barrel, is dropped into the drill pipe with a 5/8 inch wire-line attached to it. This overshot drops over the latch on the core barrel and catches it and is pulled out by small engines attached to the wire-line reel. The barrel is dropped into the hole, core is cut, pulled out, and looked at in about an hour's time. Thus a complete coring job is usually through in eight hours. After the core record is determined the oil string is set.

Wells are washed in with clear water and brought in under small chokes. All of the wells are flowing.

The water for field operations is furnished from shallow water wells dug to depths at or near 500 ft. These wells are producing from the Lissie sands and good water is produced. Key water wells are dug in various parts of the field and pipe lines are laid from these key wells to the drilling site.

Gas is furnished to the boilers from excess gas produced and from the shallow gas well on the field. A large supply of gas is available if ever needed because of the gas cap overlying the oil sands in the eastern part of the field.

PIPE LINES

There is only one pipeline serving as an oil outlet at Hastings, and this line is owned by the Pan American Pipe Line Company, which is a subsidiary of the Stanolind Oil & Gas Company. The Pan American Pipe Line Company buys all of the oil from all companies and transfers the oil through their line to the Pan American Refinery at Texas City, Galveston County, Texas. Texas City is located on the west shore of Galveston Bay 24 miles southeast of Hastings.

The pipeline leading out of Hastings is a 6-in. diameter line to the town of Webster, 8 miles east of Hastings. At Webster the line is 8-in. in diameter and remains that size to Texas City, 16 miles southeast of Webster. Two pump stations are used to pump the oil through the lines: one at Hastings, and the other at Webster.

ESTIMATED RESERVES

A reasonable and conservative estimate of ultimate recoverable oil at Hastings, in the author's opinion, is 520,284,000 bbl. This estimate is based on a study of the development map of the field as of July 26, 1937.

In computing this estimate a recoverable factor of 800 bbl. per acre foot of actual sand was used. In some of the producing horizons as much as 70 percent of the section was subtracted from the whole in order to obtain actual or effective sand thickness in the section. Over the entire field an average of 59 percent actual sand in a producing horizon was used for final computation of ultimate reserve. In other words, if the top of the sand horizon was found to be at 6,030 ft. and as the water level is 6,130 ft., the section involved would be 100 ft. However, for final results, only 59 ft., or 59 percent of the section was considered to be sand, and the rest of the section was not included in the reserve figures.

It is also necessary to state that the 800 bbl. figure was obtained by using the volumetric method and formula for computing oil reserves. Acreage, thickness of sand, percent saturation, percent porosity, percent recover, and the factor "7778" were used in this determination. In other words, the 800 bbl. figure is a factor derived by this volumetric method. The author considers this "800 bbl. per acre foot" very conservative.

The west side of the centra' graben was considered separate from the east side because of the gas cap present in the east side. On the east side only that portion of the section above the general water level of 6,130 ft. and below the oil/gas contact of 5,990 ft. was considered, and on the west side of the central graben all of the producing section above the water level was used in the calculations without any subtraction due to gas cap. Two sets of figures were obtained: one on the west side of the graben, and one on the east side.

Based on well log and geological data it is considered that 2,352 acres would be productive on the east side. From this total of 2,352 acres, 840 acres have an average thickness of 140 ft. of producing section, 882 acres have an average thickness of 100 ft., 280 acres have an average thickness of 75 ft., 250 acres have an average thickness of 35 ft., and 100 acres have an average thickness of 17 ft.

These average thicknesses of producing sections are on a 100 percent sand basis; however, only 59 percent of the section was considered to be actual oil sand and 41 percent was considered shale. This figure of 59 percent is very conservative. Nevertheless, taking 59 percent of the actual producing horizon as sand and multiplying that figure by 800, which represents the number of barrels per acre foot, the reserve is calculated. On this basis for the east side, a total of 108,584,000 bbl. of oil is the estimate for ultimate recoverable oil from that side, or an estimate of 46,000 bbl. to the acre.

On the west side there are 2,270 acres which are considered to be productive. From this figure, 1280 acres have an average thickness of 530 ft. of producing section, 400 acres have a 340 ft. section, 320

acres have a 235 ft. section, 200 acres have a 160 ft. section, and 70 acres have a 50 ft. section. Based on 59 percent of actual sand in the section, the 2,270 acres would produce 411,700,000 bbl. of oil, or 181,370 bbl. to the acre.

Adding the two sides together, the ultimate recoverable oil from the entire field is 520,284,000 bbl. of oil, or an average yield per acre of 112,543 bbl. of oil.

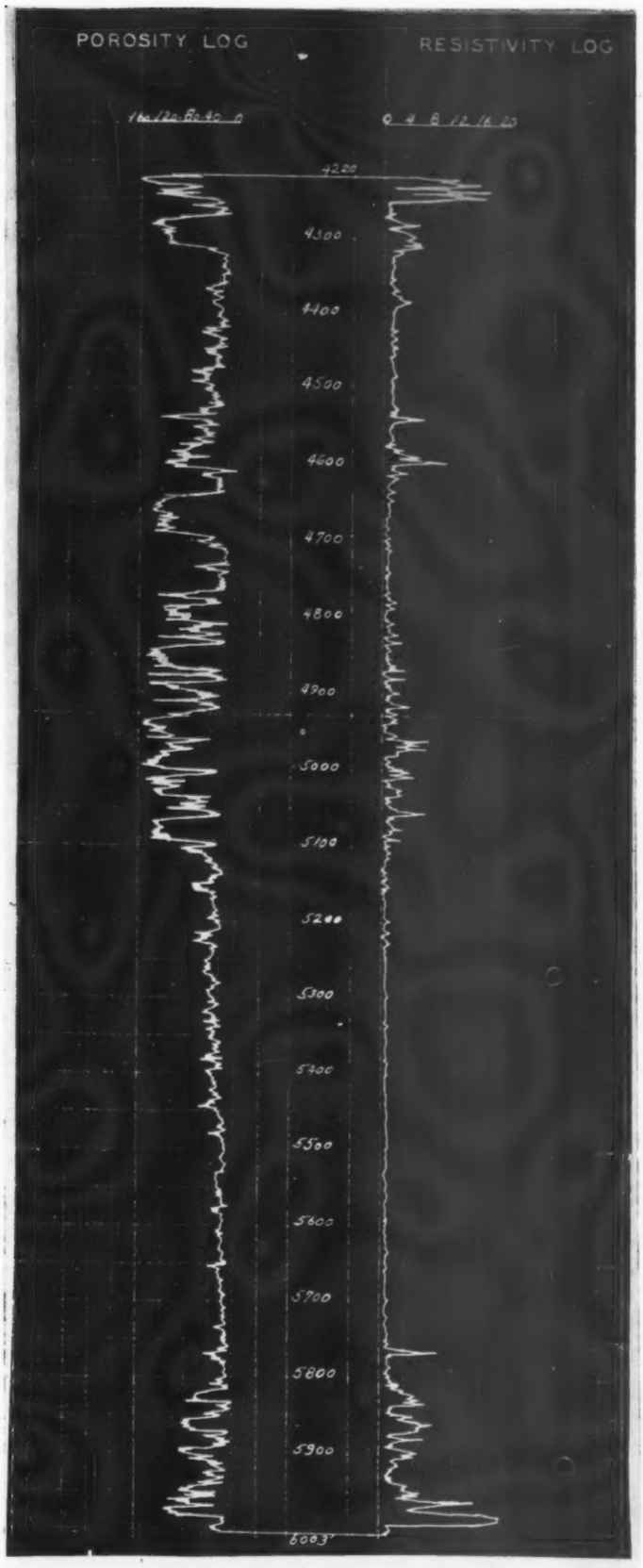
From this ultimate recovery of 520,284,000 bbl., 5,300,000 bbl., or about 1.98th, has already been produced. These figures certainly prove that Hastings is undoubtedly one of the most prolific fields in the Gulf Coast.

COST AND PROFIT

The total cost of drilling and completing a well into the tanks at Hastings is $22,000.00. The Stanolind Oil & Gas Company has completed 184 oil wells, 2 gas wells, and 5 dry holes; the Humble Oil & Refining Company has completed 61 oil wells, one gas well and no failures; and the independents have completed 19 oil wells, no gas wells, and one failure. Up to July 26, 1937, there have been a total of 271 wells completed for an estimated cost of $5,962,000.00. Adding to this figure the costs of gaugers and incidental upkeep to the leases, the total cost can be estimated at $6,500,000.00. Each well has been drilled on a 10-acre ruling proving 2,660 acres as productive on a per well basis, and on an estimate of 112,543 bbl. of recoverable oil per acre which is based on the average per acre yield over the entire field, the present wells will ultimately produce 299,364,380 bbl. of oil. The recent average price for oil at Hastings is $1.23 per barrel, and the total price for 299,364,380 bbl. at present prices is $388,228,187.40. Therefore the profits from the completed 271 wells, of which 266 are producing, is $381,728,187.40. These figures must not be confused with the estimate of ultimate reserves for the field which is given above.

PRORATION

The production at Hastings is controlled by the Texas Railroad Commission. Each well is prorated according to the factors set by the Commission, and the production per well under proration has varied from 47 bbl. to 105 bbl. The figure for each well is set every month. New wells affect the proration schedule as these wells increase the field production, and necessitates a decrease in per well allowable. At this writing the average per well allowable is 60 bbl. per day, or 15,960 bbl. per day for the field, or 478,800 bbl. per 30-day month. At a rate of proration based on 500,000 bbl. per month, the field would produce over 1,040 months or approximately 87 years.



Electric log of Stanolind Oil and Gas Company's J. W. Miller No. 1, showing the producing section as well as the middle oligocene formation above the sand.

AUSTRALIA'S SEARCH for Oil Continues

Although Production Thus Far Is Limited to One Well Yielding 200 Gallons Daily, Drilling Activities Are Being Carried Forward in Several Areas—Exploration in Papua and New Guinea—Shale Oil Production Organized in New South Wales and Tasmania.

MELBOURNE, AUGUST, 1937

SINCE the Commonwealth government, in June of last year, established a fund of £250,000 as an aid to exploration for oil in Australia and in the territories of Papua and New Guinea a considerable amount of prospecting has been carried on, some of it with assistance from this fund and some quite independently. Despite occasional newspaper dispatches telling of the bringing in of gushers, as the result of one or another operation, drilling thus far done has resulted in no substantial production. It has yielded evidence of the existence of oil in certain districts, enough at least to encourage further efforts to develop a moderate amount of production.

Advances from the Commonwealth fund of £250,000, it may be pointed out, are carefully restricted. Interests seeking support from the fund must put up pound-for-pound of whatever amount they receive and the advance is in the form of a loan. This insures that only organizations of financial responsibility can obtain assistance from the state. Grants of assistance even then must receive the endorsement of a committee of technical experts and the location of the proposed operations must have their approval. In some cases individual states have given a certain amount of financial backing to drilling enterprises. Several projects now under way, however, are being carried forward without state or federal financial support.

Production amounting to about 200 gal. of heavy oil per day has been achieved at one point. This is at Foster's Bore, Lakes Entrance, Victoria. The oil has to be recovered from emulsion with alkaline water, after pumping from Upper Oligocene glauconitic sandstone to a depth of about 1,250 ft. This is the only producing well in Australia at present, but the Australia Oil Syndicate, which controls it, has been promised assistance from the Commonwealth fund to embark on an approved programme of developmental work which may result in neighboring wells being brought to similar production. The oil has an A.P.I. gravity of 15 deg. (s.g. 0.960) and can be used as a fuel oil or for lubricating stock. Accumulation may be governed by stratigraphic rather than structural conditions, and there is little evidence available on which to base predictions of greater production.

Scout drilling for structures in Gippsland has been conducted under a joint State and Commonwealth agreement, and the results to date have been to indicate that the east-west subsurface anticline south of Sale has a pitch towards the east. To test the possibility that some oil accumulation may have occurred at the eastern end, the Lake Wellington bore is to be deepened from 2,200 feet until it passes out of the Lower Oligocene lignitiferous series, probably into fresh water Jurassic beds. Part of the cost of this work will be borne by the Commonwealth fund. The total amount promised from the oil exploration fund to three ventures in Queensland, two in New South Wales and two in Victoria is £34,751, to qualify for which the various prospecting companies have to spend £48,847 from their own funds.

Freney Kimberley Oil Company has carried out extensive geological surveys in the Kimberley division of the north-west part of Western Australia. Structural conditions in the Permian beds are favorable for oil accumulation, and the company is understood to have been promised financial assistance from the Commonwealth fund when it can apply an equivalent amount from its own funds for test drilling.

Two test wells are being operated in Queensland by Drillers Ltd. (a subsidiary of Oil Search Ltd.) with financial assistance from the Commonwealth fund, but neither has produced any quantities of oil. Hutton Creek bore, 65 miles north of Roma, is now 3,715 ft. deep, at which depth it is in beds of Middle Bowen (Permo-Carboniferous) age. Thirty miles north of this bore is the Arcadia test bore, from which a wet gas was obtained at a depth of 1,315 ft. in Permian beds. By the end of May, 1937, a depth of 2,618 ft. had been attained, and drilling has been suspended until further gas analyses and equipment are available.

Murilla Oil Company has drilled a well to a depth of nearly 2,000 ft. at Miles, 90 miles east of Roma, Queensland, and Australian Roma Oil Company has made a shallow bore near Brigalow, 150 miles west-north-west of Brisbane, Queensland, but in neither case was any appreciable showing of oil recorded. No governmental assistance was forthcoming for these efforts, as there were no adequate grounds for locating the bores at these sites. Scout drilling for structure has recently been resumed at Roma, Queensland, on behalf of Roma Blocks Oil Company, with assistance from the Commonwealth fund.

In New South Wales, a test bore, another venture by an Oil Search Ltd. subsidiary, is being worked with the assistance of a Commonwealth grant. This test is situated on the Kulnura structure west of Newcastle. The most recent report is that at 3,833 ft. the beds are of Upper Marine (Permian) age, and that the bore is 3,90[illegible] feet deep. It is hoped by the operators that more porous sandstone intercalations in the Upper or Lower Marine beds will prove petroliferous. Another bore, about 3[illegible] miles west of Sydney, is testing the Mulgo[illegible] dome for commercial gas or oil supplies. This work is being done by Gas Drillers Ltd., an Oil Search Ltd. subsidiary, also with assistance from the Commonwealth fund.

NEW GUINEA AND PAPUA

Four concessions have been granted to oil prospectors in Papua, and two in the Mandated Territory of New Guinea. Oil Search Ltd., of Sydney, holds a permit to operate in an area of 19,000 square miles in the Sepik district of the Mandated Territory, and a drilling site has been chosen. Machinery is being assembled, roads are being cleared, and an aerodrome is in course of preparation at the site, to enable communication by air with Wewak on the coast. Islands Exploration Company Ltd., a subsidiary of Standard Vacuum Oil Company, has permission to prospect a large area along the north-eastern coastal belt of the Territory.

Tanker unloading gasoline at Berry's Bay, installation of Commonwealth Oil Refineries, Ltd., Sydney, New South Wales.

Three companies have been operating for nearly a year on areas totalling 53,000 square miles in Papua: Islands Exploration Company Ltd., controlling 21,000 square miles; Papua Oil Development Company Ltd. (sponsored by Royal Dutch-Shell), 20,000 square miles; and Oriomo Oil Company (a subsidiary of Oil Search Ltd.) 12,000 square miles. A fourth company, Papuan Apinaipi Petroleum Company Ltd., was recently granted a permit to operate over an area of seventy-five miles north-west of Port Moresby. The intention is to drill the Jokea-Apinaipi dome and other structures which have already been mapped in some detail. The conditions under which the concessions were granted include an obligation to spend considerable sums of money per annum on adequate geological and topographical surveys. No grants from the Commonwealth fund have yet been made for work in Papua or New Guinea.

SHALE OIL DEVELOPMENTS

Although the offer made by the government last year to encourage production of shale oil by extending protection in an amount equal to the customs duty of 7d. per imperial gallon and excise taxes of 5½d. per gallon brought no immediate response, it appears now that operations at the Newnes field in New South Wales will be put under way shortly, utilizing the works constructed there several years ago. Revival of this project is due largely to the efforts of G. F. Davis, a Sydney industrialists.

Following extended negotiations an agreement providing for the production of oil from these deposits has been made ready for signature. The terms of the agreement are that the Commonwealth government shall provide an amount of £334,000, and allow a remission of excise duty for 20 years on an annual production of 10,000,000 gal. that the New South Wales government shall provide £166,000 and allow freight and other concessions, and that Mr. Davis shall add another £166,000. The operating company, which Mr. Davis will control, will undertake the development without delay, but it may be 18 months to two years before production is attained.

Adelaide Oil Exploration Company holds a mining lease over the shale deposits near Latrobe, Tasmania, and is said to have successfully negotiated with the Commonwealth government for duty exemptions on the importation of machinery. An expert of the T.V.P. Corporation, an American organization, is advising the company, and with modern methods it is hoped to treat 1,000 tons of shale per day.

OIL FROM COAL

After he had studied the production of oil from coal in Great Britain and Europe, a report by Sir David Rivett, Chief Executive Officer of the Council for Scientific and Industrial Research, was tabled in Parliament in June. His estimate is that a hydrogenation plant to produce 45,000,000 gal. per annum from bituminous coal would cost £11,000,000 (Australian), and for brown coal treatment £12,000,000, the production cost of petrol being about 1/s. 5d. per gallon, if a return of 6 percent on capital is assumed, with amortisation in fifteen years.

The German Fischer Tropsch process was also carefully examined, and, according to the Rivett report, the cost of production per gallon of motor spirit would be of a similar order.

Low temperature carbonisation was dismissed owing to the lack of markets for the chief by-product, semi-coke, which would make the cost of producing oil still higher.

In view of the heavy outlay involved, the Commonwealth government announced that no further action would be taken at present to develop production by these methods.

The premier of Victoria (the Hon. A. A. Dunstan) however stated on his recent return from a world tour that further investigations would be made by his government into the possibility of utilising the extensive lignite deposits of Victoria for the production of oil, and this will presumably be a State enterprise if it is undertaken.

The possible use of power alcohol, produced by the Colonial Sugar Refineries, is being investigated by L. J. Rogers, the Commonwealth Fuel Adviser.

ROUMANIAN EXPORT Decline Makes Danube Most Neglected Petroleum Route in Middle Europe

By Eng. Chem. Andr. Andor

THE DANUBE has been unjustly reproached for not flowing up-hill—that is to say, from east to west. However, nature and engineers have provided all that could be desired. It lacks no advantages and hundreds of tankships use this marine highway.

Danube oil traffic reflects to a great extent the position of Roumania's oil export trade. Russia is no longer a dominant figure in the export market, while Poland cannot produce enough for her own use. From the geographical aspect Roumania is the only country now able to provide the Danube basin with its liquid fuel supplies, but in other respects the situation is quite different.

All of the country's oil export trade by way of this river is from the port of Giurgiu, which is connected with the oilfields by pipeline, railroad and asphalt highway. Giurgiu is situated about 130 km. from Ploesti, Roumania's refining center, and 70 km. from Bucharest, of which it may be considered the port. It is the most important importing center of machinery and other industrial products on the Danube.

Extent of development of this petroleum port is indicated by the steady growth in exports over the past five years, so that the figure for 1936 was approximately double that of 1932. All of this would indeed indicate a very fine perspective, were it not for the fact that the rise was interrupted at the end of 1936 by a fall corresponding to the increase built up so laboriously in the past few years. Exports during the first half of 1937 were but 250,000 tons, or about 50 percent decline. The cause of this sudden descent lies in the politico-economic position of the Danube basin.

International accord in petroleum affairs between Roumania and its neighbors, Austria and Hungary, was broken off during 1936-7, and the increased demands of Roumania for freer and more stable exchanges for petroleum products have not been approved by Austria up to the present. Negotiations are proceeding with Hungary for an exchange of oil for iron.

Germany is also reported to be taking scarcely any oil from Roumania.

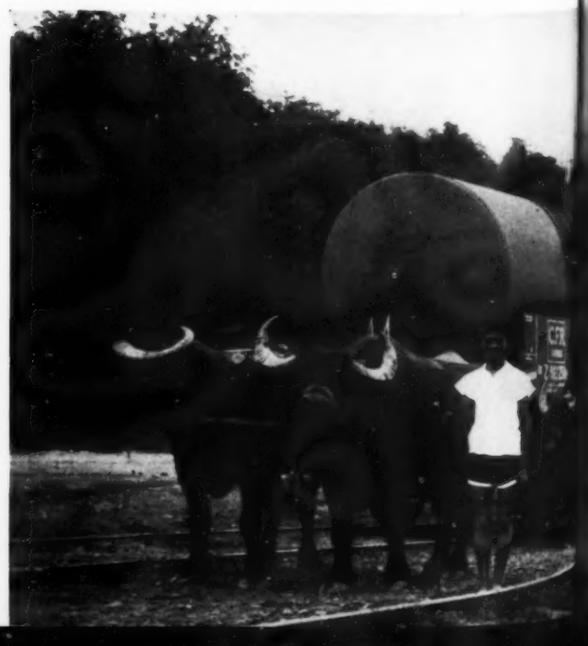
Meanwhile Austria and Hungary are likely to make appreciable efforts to minimize all oil importations. Drilling for petroleum will be spurred on, compulsory admixture of alcohol with motor spirit will be enforced, while fuel oil consumption will be repressed and replaced by coal wherever possible. Paradoxically, the appearance in the Danube of crude oil from overseas is receiving earnest consideration.

Refined Oil Exports Through Giurgiu

Year	Tons
1932	556,543
1933	704,598
1934	763,819
1935	858,289
1936	1,028,423
1937 (6 months)	250,000

Pending settlement of these trade disputes the immediate position is entirely unfavorable. There continues to be a certain amount of sea traffic, but about 150 tankers, aggregating about 100,000 tons deadweight, are held up at Giurgiu. The question remains as to whether the logical destiny of Roumanian oil lies in the neighboring countries and whether the route through the Danube basin from the Carpathians is not shorter than that to the west Atlantic coast.

Loading jetty at Giurgiu—Danube oil traffic has fallen off to a great extent from its previous high levels.



Oxen are used to switch tank cars at the Giurgiu junction, Roumania.

UNITED KINGDOM Gasoline Prices Reduced

By Alec H. Day

MAJOR importing and distributing interests in the British motor spirit market are determined to keep prices in conformity with world oil conditions. This fact was made plain by the surprise reduction of ½d. per gallon in all prices at the end of July, after the high level of 1s. 7½d. per gallon for first-grade spirit had been maintained for three months.

Many quarters of the British oil industry were surprised at the reduction made at that particular time. Although some doubt was expressed as to the complete justification for the lower price level, there was a general disposition to accept the official explanation, put out by the National group, that the reduction in the laid-down cost of motor spirit was the reason for the decrease in selling prices. Despite the decline in tanker freights in July, there was considerable conjecture among some as to the possibility of other factors having contributed to the lower price range. Speculation on these lines was inspired by the knowledge that the British motor spirit market had only this year become really renumerative to the big distributing companies, after years of unprofitable working.

Amazement at the reduction in quotations at a time when the motoring demand for spirit was at its height found expression in the British press in many suggestions as to the cause, most of them very wide of the mark. Arrivals in British ports of distress cargoes of spirit, and keen competition from independent distributors, were among the suggested reasons for the fall in prices.

Neither of these stories has any basis in fact. No distress cargoes arrived for sale, and supplies of motor spirit remain difficult to obtain in any considerable quantity. Similarly, competition from the smaller independents is probably less now than at any time within recent years. The Independent Petroleum Federation, established some years ago to regulate and co-ordinate the business of the smaller unaffiliated distributors, claims to be working efficiently, with a considerable increase in membership.

Another press story was that oil products from Bahrein were to be introduced into the British market almost immediately, and that the motor spirit price cut was an advance preparation by established companies. California Texas Oil Company considered this report sufficiently misleading to cable a detailed and reasoned denial through its chairman, James A. Moffett.

An examination of the cost of motor spirit imports into the United Kingdom provides considerable ground for acceptance of the official explanation of the cut. Clean tanker freight rates from Gulf to U.K. stood at 13s 6d. per ton at the end of 1936, but rose to 35s. in March and April. This rise in costs, with the slight improvement in Gulf prices for motor spirit, was more than offset by the advance from 1s. 6d. to 1s. 7½d. in selling prices during the first four months of this year. By July, the tanker freight figure had declined to 27s. per ton, and permitted a reduction of something like ½d. per gallon in the United Kingdom price. Comparing the end of July with the beginning of the year, tanker freights had risen by 13s. 6d., or just over ½d. per gallon, while selling prices were 1d. per gallon higher.

The accompanying table reveals the recent responsiveness of quotations to changes in tanker freights.

At the price now established, the market is probably barely payable to the smaller distributor carrying low overheads. Based on a Gulf price of 6¼ cents per American gallon, the sterling price per Imperial gallon is 3.6d. Freight, landing charges and evaporation losses account for a further 1.3d., making a total laid down price of 4.9d. subject to the 8d. duty, and giving a total price of just over 1s. per gallon.

There is no comparison between this figure and the 1s. 7d. per gallon now charged for No. 1 spirit. Only a small proportion of the total trade is conducted at this figure. A considerable percentage of business consists of commercial grades, now selling nominally at 1s. 5d. per gallon, and a far larger amount is done by contract at a much lower figure. After allowance for inland handling, blending and laboratory work—and the margin allowed to retailers on motor spirit sold through pumps—the margin of profit to importers is probably very narrow, and there is no doubt that it is the intention of the large interests in the British market to keep it so.

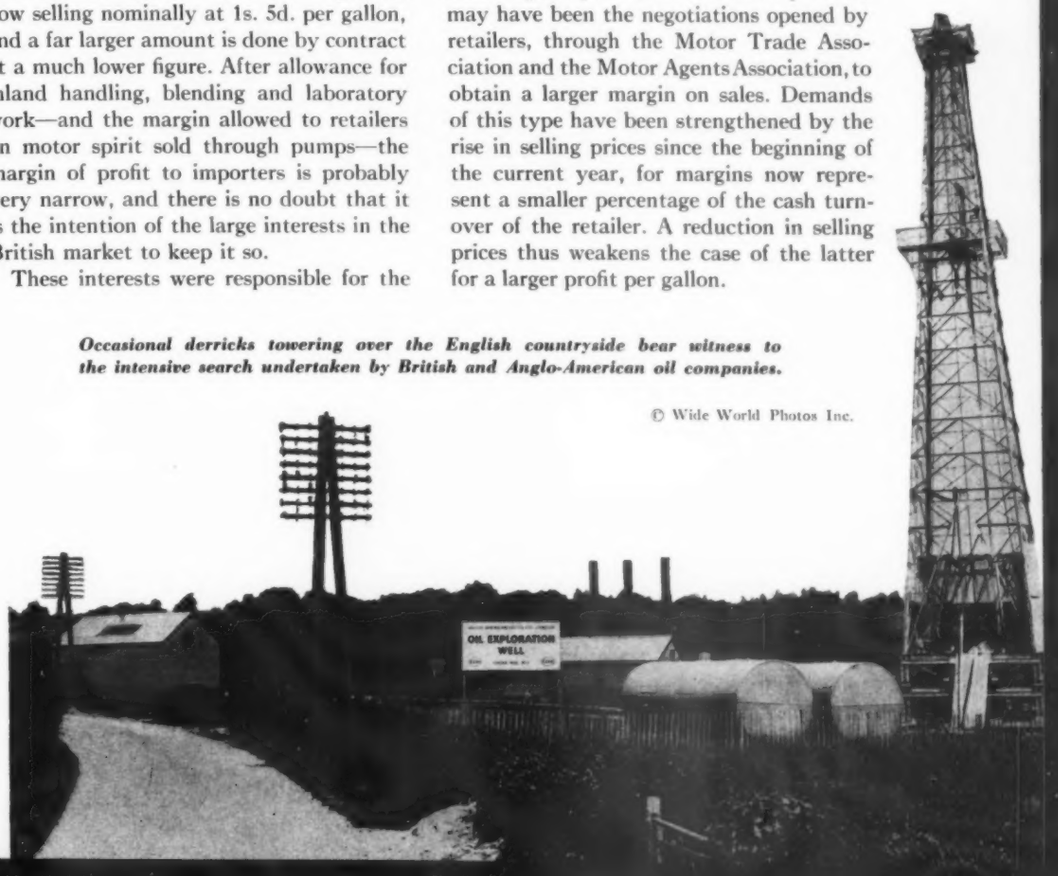
These interests were responsible for the price cut, tanker freights, and to an appreciable extent Gulf prices, which make little difference to their own costs. They are mainly engaged in importing oil products which are, in fact, their own production through affiliates or subsidiaries, and these products are invariably carried in their own tanker fleets. Fluctuating prices and freight rates, do not affect to any extent their profit-earning capacity.

U. K. Prices for First Grade Gasoline

Date established	Price excluding duty	Duty	Total Selling price
	per Gallon		
	d.	d.	s. d.
March 3, 1931	10½	4	1—2½
April 28, 1931	10½	6	1—4½
May 22, 1931	9½	6	1—3½
July 18, 1931	8½	6	1—2½
Sept. 10, 1931	8½	8	1—4½
Sept. 14, 1932	11½	8	1—7½
May 17, 1933	9	8	1—5
Nov. 3, 1933	10	8	1—6
Mar. 22, 1934	9	8	1—5
May 1, 1935	10	8	1—6
Jan. 13, 1937	10½	8	1—6½
Feb. 11, 1937	11	8	1—7
April 26, 1937	11½	8	1—7½
July 29, 1937	11	8	1—7

What does concern them, however, is keeping the British market from becoming so remunerative a distributing field as to attract new competitors, although there may be no immediate threat of competition. With most retail distributors of motor spirit owning their own pumps, and thus free to change their allegiance at any time, the market is to some extent vulnerable. An obvious remedy, although not always pleasant for the distributing industry, is to restrict profits to a strictly sober level.

While this consideration was doubtless the main factor in the latest reduction of motor spirit prices, a contributory cause may have been the negotiations opened by retailers, through the Motor Trade Association and the Motor Agents Association, to obtain a larger margin on sales. Demands of this type have been strengthened by the rise in selling prices since the beginning of the current year, for margins now represent a smaller percentage of the cash turnover of the retailer. A reduction in selling prices thus weakens the case of the latter for a larger profit per gallon.



Occasional derricks towering over the English countryside bear witness to the intensive search undertaken by British and Anglo-American oil companies.

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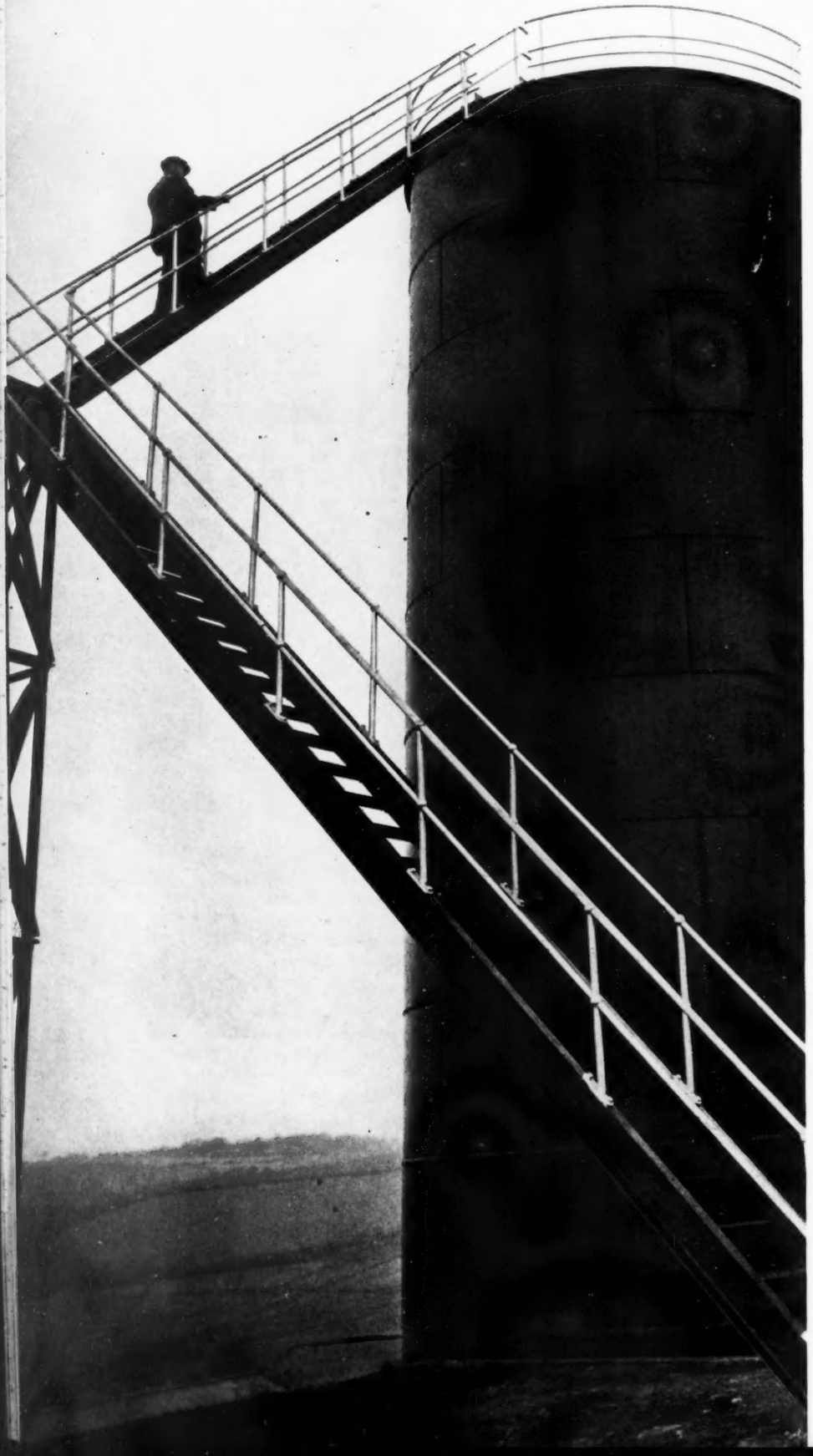


Principles and Effects of TANK FIRES

By U. Driebergen

Royal Dutch-Shell Group

ALL OIL PRODUCTS, even those obtained after laborious scientific research and ingenious technical manipulations, may be said to end their existence by burning in one form or other. This may take place explosively, as in motors, evenly, as in furnaces, or very slowly, as with lubricants.

Only when the products are burnt in a way not intended is there loss and there may even be serious danger.

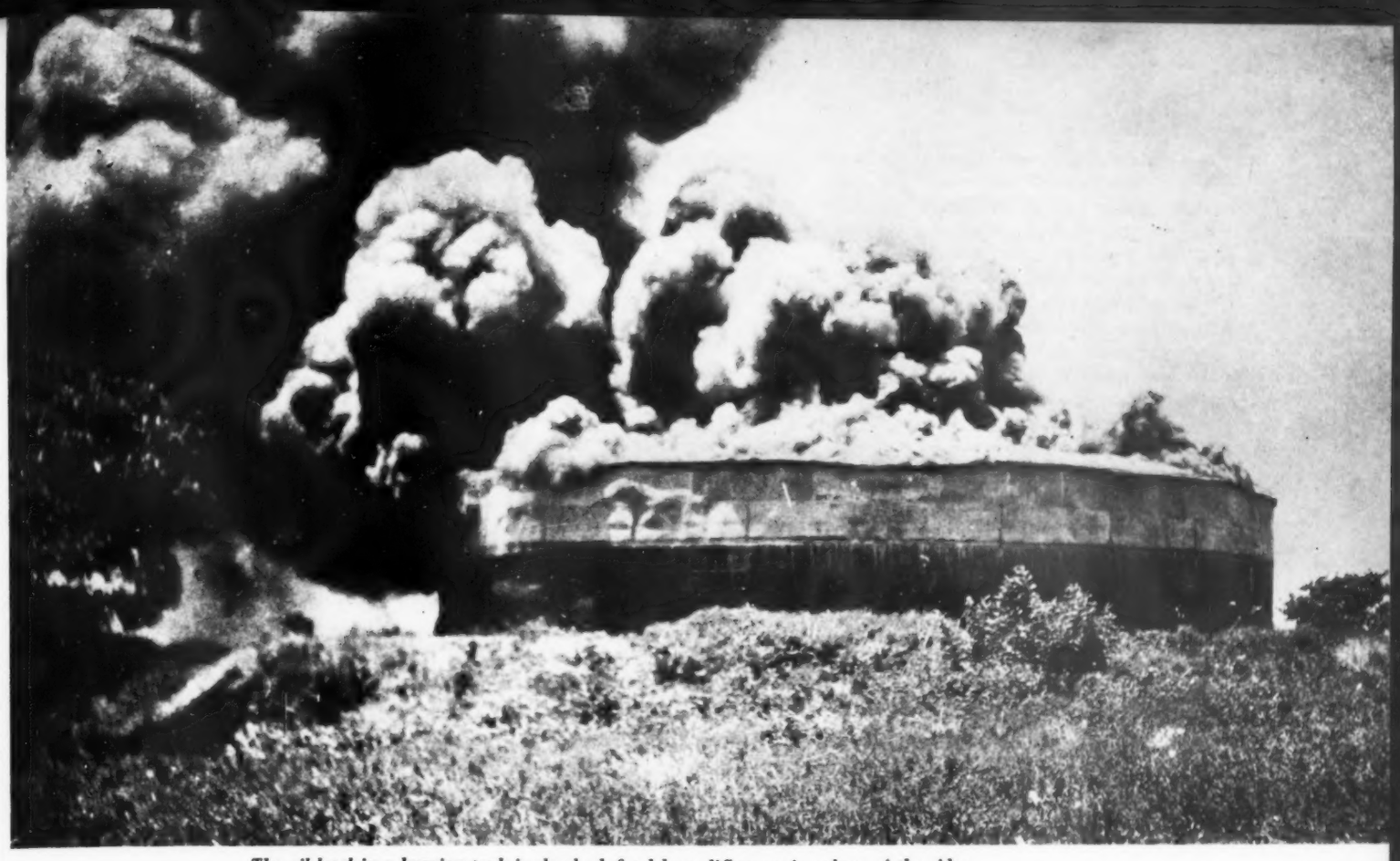
Problems of fires and fire-fighting cannot be resolved by purely theoretical consideration, but can only be thoroughly dealt with if we have at our disposal a number of cases with all circumstances, causes, and phenomena observed during the fire and its extinction accurately recorded in detail.

Leaving out of consideration any other than tank fires, and assuming that we have the exact story of 100 tank fires, it is a question of mere statistical tabulation to reach an idea as to their causes and as to the percentage of cases where lightning, imprudence, etc., could be blamed. Each separate cause again can be a subject of study, for instance, why one tank is affected and another not. Then it may appear that it is the location, the height relative to the surroundings, the trees in the neighbourhood, the geological formation of the subsoil, the frequency of thunderstorms in a certain region, or the gas-tightness of the roof, which exercises the most decisive influence. From this study can be deduced standard rules of safety, which have to be adhered to as far as possible in the planning and construction of new tanks.

In practice it is not always possible to avoid all risks, while statistics still show a considerable number of "unknown causes." To account for the latter several hypotheses are put forward, many of which are not at all reliable or even probable. An extensive field lies fallow here for the plough of the experimental research worker.

To a much less degree is this the case with the study of fires themselves and methods of extinguishing them, though it is true, even here, that very peculiar phenomena have been observed. An example is the case where the roof of a tank was torn off all round the edge by a violent explosion, thrown up in a rush of flames, then fell back on the tank and extinguished the fire.

There would be no correlation between such individual instances if the systematic



The oil level in a burning tank is clearly defined by a difference in colour of the sides above and below the liquid.

study of the phenomena attending tank fires had not already led to a few basic theories establishing connection between apparently divergent facts, from which again unmistakeable indications can be deduced as to how one should act in certain circumstances, what actions are dangerous or useless and what is actually the best method of extinguishing fires.

The basis of this study should never be lost sight of and may be briefly expressed as follows: a flame is essentially a body of burning gas, from which it follows that it is not the liquid oil itself which burns, but the vapours evolved from the liquid by heat. Simple experiments readily prove this theory correct.

A burning match, quickly immersed in a tray of kerosine or lubricating oil, will be extinguished without causing fire. If plunged into light gasoline, however, a fire results.

If a flat iron tray is heated without using an open flame (e.g. electrically) and gasoline is poured thereon in such a manner that the resulting vapours do not come in contact with glowing parts, the temperature of the tray may rise to far above 900 deg. F. without ignition. Lubricating oil under these conditions ignites at approximately 600 deg. F.

If a blue-burning Bunsen flame is set to burn horizontally and gasoline is allowed to drop through it, a small vertical flame is observed above and below the flame as the drop passes through it, but the drop of gasoline itself can be collected. If this experiment is carried out with drops of lubricating oil they fall in the form of burning globules.

How can we conclude from these three experiments that it is the gas that burns and not the liquid?

As is well-known, gasoline boils (and consequently evaporates) at a much lower temperature than lubricating oil under equal pressure conditions. In the case of these experiments this latter condition is satisfied, since the experiments are carried out at atmospheric pressure. With the first experiment, in the case of heavy oil, the time elapsing during the approach of the burning match to the liquid surface is too short for sufficient development of gas; this is not so, however, in the case of gasoline. In the second and third experiments heating causes evaporation, but much heat is necessary to produce and maintain evaporation, so that if the rate of evaporation is very high, the heat supplied may well be sufficient only for evaporation without heating the liquid itself, (so that in the second experiment the plate is locally cooled below the temperature necessary to ignite the gases formed). Owing to this high rate of evaporation the drop of gasoline in the third experiment remains relatively cold and the small vertical flames which are observed are the ignited gases which have been developed. On the other hand the drop of lubricating oil is heated immediately, because the development of gas at low temperature is slight; the globule heated to its boiling point continues, however, to develop some gas, which ignites immediately. Therefore, the gas is the carrier of the fire.

Besides the possibility of common combustion, hydrocarbon vapours present a further potential danger, i.e., where they are mixed with air in a proportion of approximately one to eight percent by volume; not only is a fire caused by ignition of the mixture, but also an explosion. Such explosive mixtures are made use of in internal combustion engines. If the concentration exceeds eight percent (this figure is not constant; for some grades of gasoline it is seven percent) the mixture is combustible but no longer explosive, being too rich. Hence, if a gasoline storage tank, the gas space of which contains a vapour-air mixture of explosive composition, takes fire, the results are drastic, and the greater the resistance to which the exploding gas is subjected the more terrible is the force of the explosion. The tank designer therefore always takes care that the roof, or the connection between the roof and the shell, should form the weakest point in the construction. It has occurred that, owing to age, a tank roof was repaired without attention being paid to the condition of the bot-

tom curb, which afterwards proved to have become weakened in the course of time; when a fire of an explosive nature broke out shortly after the repair, the roof was blown off, carrying the shell with it, as the corroded bottom rivets sheared off, and the result was that the burning oil filled the entire space between the fire-walls. Where there are other tanks within these walls, they are bound to take fire as well. If the other tanks contain light products, the risk that they will also explode is slight, for their liquid contents are heated by the surrounding burning oil and consequently evaporate, so that the air-vapour mixture quickly becomes too rich and is no longer within the explosion range. In this connection it will be clear that in the case of heavy oil the risk of explosion is much greater, since the formation of vapour takes place much slower, so that the composition of the air-vapour mixture remains for a long time within the explosion range. If the fire develops in such a manner that surrounding flames or sparks reach these gases, an explosion cannot be prevented.

In many tank installations round open trays are mounted at the top of the roof, into which a cold water line terminates. When the water is turned on it flows over the edges of the tray over the tank roof and around the shell. The intention of such sprinkling systems is to protect the tank from radiated heat originating from any adjacent fire. Strangely, putting such a sprinkling system into operation is not always wise. Once the radiated heat heats the tank to such a degree that evaporation occurs, the vapour-air-mixture in the gas space soon exceeds the explosion limit, and the greatest danger is thus past. If the neighbouring fire is of such a nature that a rain of sparks occurs, as in the case of burning wood and there is consequently a great risk of the gases escaping from any open manholes or leaky tank seams being directly ignited, it is not advisable to put the cooling arrangement into operation, because, during cooling, sufficient air may be drawn in to form an explosive mixture.

A gasoline tank fire is far less dangerous and can be extinguished more easily than a fire in a fuel oil tank. Circumstances attending tank fires are quite different from ordinary small fires, such as burning pools of gasoline or heavy oil in open air. As is known from accidents with airplanes and motor-cars a gasoline fire is invariably of a catastrophic nature, owing to the very high rate of gas development. Large flames are immediately formed, which cannot be passed, while in many cases a burning pool of lubricating oil can be beaten out.

Let us compare the nature of two fires, one in a gasoline tank and one in a fuel tank, where in each case the roof has been blown off entirely or for the greater part. In a tank which is already burning, the possibility of stopping the formation of vapour by cooling the shell and the liquid, thus to stop feeding the fire, may practically be disregarded. Cases are known in which success has been achieved with small tanks containing heavy oil, but it will be shown hereafter that in the case of failure a much greater risk is involved, so that in spite of these recorded examples such a method of fire extinguishing is not justified. Consequently only the well-known foam fire extinguishing method remains, which method is based on the principle of effecting a temporary but effective seal between the oil and atmospheric oxygen, and between the oil and the heat of the burning gas to avoid further evaporation. In the case of a large tank the foam requires some time to spread over the entire surface and should therefore be resistant to the surrounding flames. Foam is therefore introduced from several points on the circumference of large tanks, in order to reduce the time required for effecting a layer of foam. The foam bubbles, which as a rule are rendered elastic by means of liquorice extract or similar substance, contain carbon dioxide, which expands by the heat, so that the bubbles burst if they are not sufficiently strong. Not only during the spreading out of the foam, but also after the layer of foam has been formed, and after the flames have thus been extinguished, the layer should be maintained for a certain period. This is necessary because the hot top layer of the oil continues for some time to develop vapours which may penetrate the layer of foam and ignite against the glowing hot metallic parts. Not until these metallic parts have cooled is the danger past.

In all tank fires, as demonstrated in the experiments, light oils are distilled off and the vapours arising burn immediately. The air supply in the centre of the tank fire is very insufficient, hence combustion is incomplete, and for this reason every tank fire is characterized by the formation of enormous volumes of smoke.

A light oil will not become hot (quite in accordance with the drop experiment) and with such a fire it is possible when standing on the windward side of the tank to hold one's hand against the tank shell only a few inches below the burning oil level. The tanks are painted as a general rule and, as one of the illustrations shows, the height of the burning liquid in the tanks can be clearly seen because the paint blisters only near the liquid level.

Heavy oil is heated by the gases burning at the surface, because, evaporation being only slight, nearly all the heat is available for heating the oil. (Not until the boiling point is reached, approximately 600 deg. F., does severe evaporation take place). This heat is transmitted downwards, at a rate of approximately one to three feet per hour, depending on the grade of oil. The temperature of the oil as a whole may rise to 450 deg.—500 deg. F. This increase in temperature threatens to become a great danger if there is water or emulsion on the bottom of the tank, which is generally the case with fuel and similar heavy oils. If the heat reaches this layer steam is rapidly formed, so rapidly that an explosion may take place. At a pressure of one atmosphere at 212 deg. F. one cubic foot of water develops roughly 1,700 cu. ft. of steam, so that the enormous steam bubble formed, which is further expanded by the heat, may unexpectedly belch out the entire oil content. This is called "priming," and many cases are known of persons having been burnt by the boiling oil when 30 yards or more from the burning tank. A simple calculation will show that it is necessary for the layer of water to be only a fraction of an inch deep to cause accidents of this kind. (A similar risk of oil being belched out is present where oil of a temperature exceeding 212 deg. F. is poured into a barrel partially filled with heavy oil, if water or emulsion has collected on the bottom of the barrel).

As the foam is formed by the means of water it is evident that upon its application to a burning oil surface a great increase in the sea of fire will initially be noted, as a result of the formation of steam on the surface. This is not an actual change for the worse in the fire, so that the phenomenon should never be a reason for discontinuing the further application of foam. In some cases the extinguishing work may be supported by simultaneously pumping out the tank, whereby the quantity of oil that might burn is reduced. With an effective supply of foam the interval between ignition and extinction is frequently but a half-hour.

Fire extinguishing by means of foam has been applied for only a little more than 20 years, but this method has rendered such good service that an oil concern without it is practically inconceivable. In view of the fact that a permanent foam fire extinguishing installation is rather expensive and the capital outlay involved cannot be regarded as directly productive, it is inevitable that in the course of years attempts should be made to design less expensive, simplified systems, based on the same principle. Compared with the much higher value of the objects protected and taking into consideration that factor of safety to human life, the cost of even an expensive foam fire extinguishing system is relatively low. Considering the question of complete or partial protection the slogans "safety first" and "penny wise, pound foolish" can be applied with full justification.

British Company Changes

LONDON, AUGUST 23

KERN RIVER OILFIELDS has announced that negotiations have been concluded for the subscription of part of the company's unissued capital, the additional funds to be used in carrying out extended plans of development in Trinidad and California. At the same time, it was stated that Sir William Alexander and Sir Thomas D. Nicol, associated with the subscribers of the new capital, had agreed to join the Kern River Board.

Both these new directors of Kern River are directors of Petroleum Storage and Finance Corporation, Sir William Alexander being deputy chairman. Since neither has any other important oil directorate, it was assumed in financial circles that Standard of New Jersey interests, through Petroleum Storage, had put up the new Kern River capital. So far as official information goes, however, Messrs. Alexander and Nicol may be acting in their individual capacities.

A considerable sum may be involved, only £625,000 of the authorized total of £1,500,000 having been issued prior to the addition now announced.

Kern River properties, in addition to those in California, extend to Texas, Trinidad and Mexico. Many years of unsuccessful operation culminated in 1935 in a reduction in the issued and paid up capital from £1,500,000 to £500,000, by writing down the shares from a nominal value of 10s. to 3s. 4d. The authorized capital has since been restored to its former amount and the company resumed dividend payment with a return of five percent for the year ended May 31, 1936.

Acquisition of a further interest in Cork Harbour Oil Wharves by Libitos Oilfields, Ltd., although a relatively small transaction, caused some speculation as to the intentions of Lobitos in the Irish market. In the absence of any official information from the Lobitos end of the deal, some observers were disposed to connect the purchase with Irish Free State government plans for establishing a local refining industry. Up to the present, however, there is no indication of a link-up between Cork Harbour Oil Wharves and the new Irish National Refineries project with which London and Thames Haven Oil Wharves, and Parent Petroleum Interests, Limited, are associated.

Cork Harbour Oil Wharves operates a small plant at Cork, and enjoys a tariff preference of 2d. per gallon in a total duty of 8d. per gallon. Although the refinery has been in operation for about two years, the company has not yet paid a dividend.

One half of the capital was acquired by Lobitos Oilfields and its associated company, Anglo-Ecuadorian, in 1934. Acquisition of the remaining 50 percent leaves the Lobitos group in complete control of Cork Harbour, whose refinery has already provided an outlet for part of Lobitos crude production.

Meanwhile preliminary work in connection with the Irish National Refineries plant at Dublin is proceeding. Some delay has occurred through labor difficulties, but land reclaiming operations are nearly complete, and the end of 1938 is suggested as a possible date for the opening of the refinery. No announcement has been made regarding the ultimate financing of the scheme or of arrangements for an adequate supply of crude, two of the main essentials to the success of the scheme.

U. S. Equipment Exports Up 81 Percent

EXPORT of petroleum well and drilling equipment from the United States during the first half of this year reached record levels and totalled $16,453,088, an 81 percent gain over the comparable shipments last year, valued at $9,083,065, and four percent above the previous record January-June shipments made in 1930, amounting to $15,093,620, Commerce Department statistics show.

To a considerable extent the increased export demand during the present year has been concentrated upon drilling equipment, as compared with other oil well and refining machinery. Sales of petroleum and gas well drilling apparatus during the first half of 1937 amount to $8,300,973, more than double the corresponding shipments of last year which were valued at $3,833,233 and 55 percent above the previous peak half-year exports amounting to $5,342,409 in 1930.

While the export gain in drilling equipment was distributed over many markets, outstanding increases were noted by the Machinery Division in the sales to certain individual countries. Some of the leading buyers of this class of equipment with their comparative purchases are shown in the accompanying table.

EXPORTS OF DRILLING MACHINERY

Country	Jan.-June 1937	Jan.-June 1936
Venezuela	$1,866,720	$892,316
Neth. East Indies	1,565,358	724,390
Roumania	1,067,484	153,122
Trinidad & Tobago	811,678	296,502
Canada	667,159	72,059
Mexico	395,157	158,419
Colombia	281,929	19,582
Other countries	1,645,488	3,025,843
Total	$8,300,973	$5,342,233

Export sales of all other petroleum well and refining machinery in the first half of 1937 were valued at $8,153,015, or 55 percent above the $5,249,832 worth exported during January-June of last year. Outstanding in this export gain have been the greatly increased sales to Soviet Russia during January-June of this year. These were nearly fivefold the corresponding sales in the first half of 1936. Other large purchasers were Italy, Netherlands West Indies, Trinidad, Mexico and Argentina. Smaller but still important buyers were Afghanistan, Nepal, Bhutan, Portuguese Timor, Macao, Goa, Damao and Diu. A comparison of shipments of this class of equipment is given herewith.

EXPORTS OF REFINERY AND GENERAL EQUIPMENT

Country	Jan.-June 1937	Jan.-June 1936
Soviet Union	$1,959,680	$415,672
Other Asia	1,079,761	156,943
Italy	718,228	188,817
Neth. West Indies	670,224	450,790
Trinidad & Tobago	569,539	66,704
Mexico	477,850	210,824
Argentina	432,875	343,148
Other Countries	2,244,858	3,416,934
Total	$8,153,015	$5,249,832

SCIENCE OF PETROLEUM

EDITED by Dr. A. E. Dunstan, Prof. A. W. Nash, Sir Henry Tizard and Dr. A. B. T. Brooks, The Science of Petroleum is approaching completion. Oxford University Press expects to publish it in three volumes of about 1,000,000 words each before the end of the year. It will contain some 400 articles, written by approximately 300 contributors drawn from all parts of the world.

The science of technology of the petroleum and mineral oil industry continues to progress at a remarkable rate. New fuels are constantly being marketed, and these influence the design of machinery. In the past few years motor vehicle haulage has passed more and more over to the Diesel engine, and in the next few years there will no doubt be a similar change in airplane engines. Afloat, petroleum continues to be increasingly important each year. Petroleum is becoming a source of synthetic plastic materials, and a considerable development of lubricants synthesised from coal oils is to be expected. The magnitude of the world's petroleum resources, and their prospects, are matters of major importance.

All of these subjects, and hundreds of others, are being treated together for the first time in the forthcoming work, which will become a standard reference for all who are interested, scientifically and generally, in the petroleum and mineral oil industry.

Foreign Oil Legion

JOHN A. BROWN, president and chairman of the executive committee of Socony-Vacuum Oil Company Inc., returns from Bremen September 4th, arriving in New York on the 10th. Accompanied by Mrs. Brown, he has been on a combination business and pleasure trip to England and the Continent, lasting several weeks. Mr. and Mrs. Brown included in their itinerary stops at Austria, Germany and Switzerland.

A. T. GANO, formerly working at Venezuelan Oil Concessions Ltd.'s Lagunillas warehouse, left the United States early in August for Bogota, Colombia. From Bogota he will go to the Puerto Wilches district to take charge of stores for Compania de Petroleo Shell de Colombia.

ING. GH. VINES, field superintendent at Gura Ocnetei, Dambovia, for "Creditul Minier" S. A. R., has left Roumania for an extended visit to the United States. He arrived in New York at the end of August, and is now in Los Angeles.

C. O. ISAAKSON, Colombian Petroleum Company, left for Bogata August 14th.

Lt. Col. Hickling with a senior staff group of Apex (Trinidad) Oilfields, Ltd. Lt. Col. H. C. B. Hickling is fourth from the left in the center row.

Stray bombs from Chinese planes attacking the Japanese marine forces on the Whangpoo River, Shanghai, struck the storage installation of Asiatic Petroleum Company, Ltd., with disastrous results. A. R. McGinnis, engineer of the Texas Corporation's interests passes this district daily by launch between Shanghai and the Gough Island plant of his company. He reports the slaying of large numbers of Chinese soldiers after their capture. They were lined up on the N.Y.K. Company's wharves, with their hands securely knotted behind them, he said, and then hurled into the water, where Japanese marine sharpshooters peppered them with bullets.

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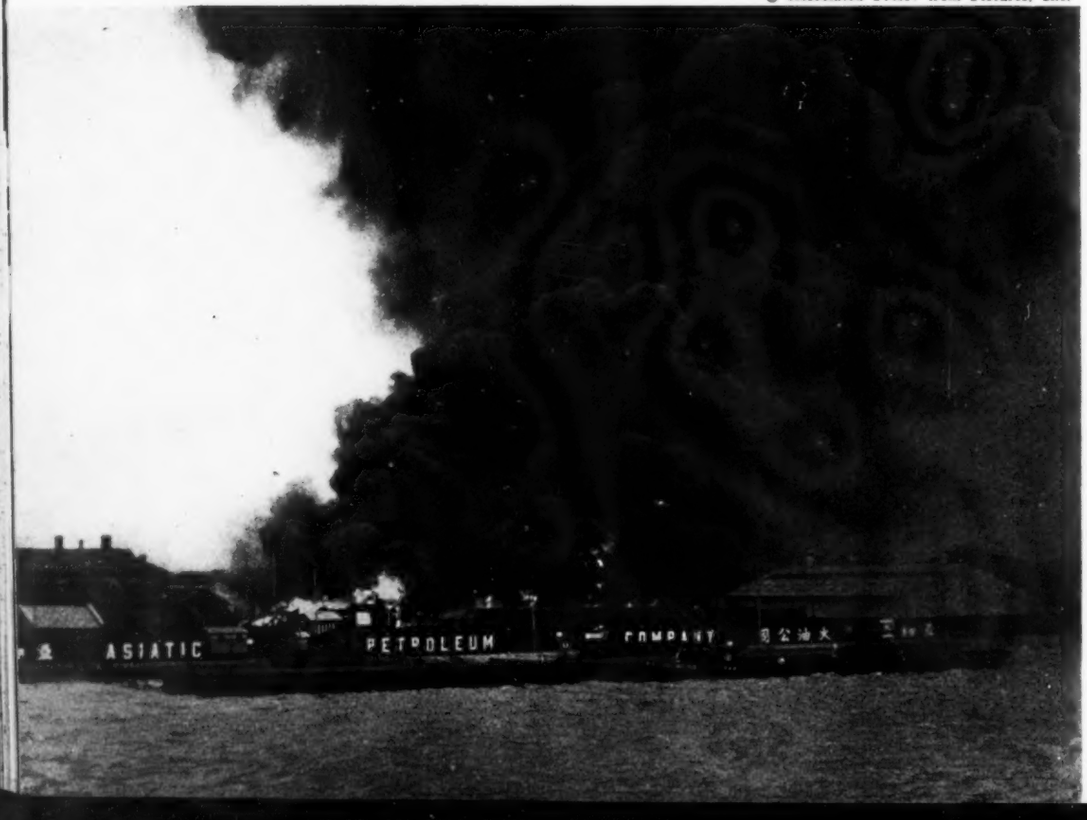


LT. COL. HORACE C. B. HICKLING, C.B.E., D.S.O., M.C., who retired from the post of attorney and general manager of Apex (Trinidad) Oilfields Ltd.—a position which he held with distinction since the inception of the company in Trinidad 18 years ago—has been appointed a director of the company.

He first arrived in Trinidad in 1919 and under his management Apex became the Colonies largest producing field within ten years.

As the only oilfield general manager to serve in that capacity for 18 years continuously, Col. Hickling soon drew the attention of the government, which nominated him an unofficial member of the Legislative Council. His retirement coincided with the coronation of KING GEORGE VI, and it was a fitting reward to his career when His Majesty bestowed on him the honour of Commander of the British Empire. Col. Hickling did a tremendous amount of work as legislator and as a member of various government committees, the most prominent of which was as chairman of the Traffic Safety Committee. In the field of sport he played an active part in founding clubs for his employees.

Fay Bishop, seated on his most recent tusker.

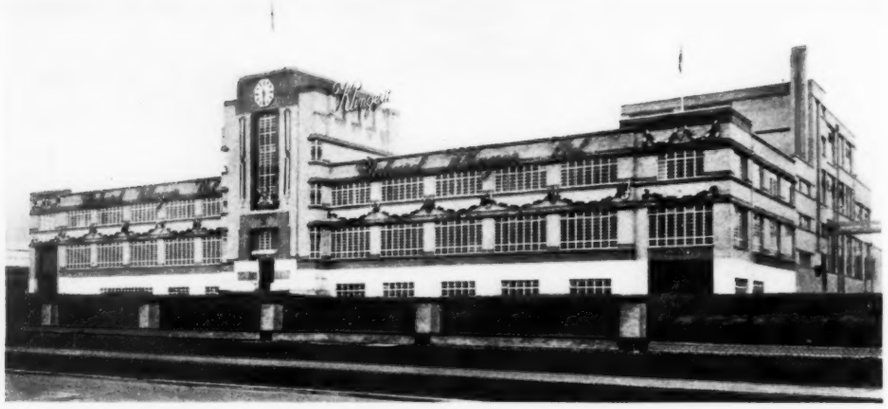
BEN F. MUN, well-known in Californian independent oil circles, was killed in an airplane crash in the vicinity of Brussels, Belgium, July 28th. When 19 years old he started in the oil tool supply business, later going into oil production at Long Beach. Among others, Mr. Mun headed Humble Oil Company and Magnolia Petroleum Company (not connected with the similarly-named Mid-Continent operators). He was 35 years of age when the fatal accident occurred.

FAY BISHOP recently arrived in Los Angeles after resigning from his position as assistant drilling superintendent for Burmah Oil Company, Ltd. at Khodaung, Upper Burma. Well-known as an enthusiastic hunter—his trophies seem to include every type of animal existing in that part of India—Mr. Bishop has been spending his time organising a hunting expedition, returning to Burma in the latter part of September. It is believed that the object of the party, which will be in his charge, is an elephant hunt, at which he is highly successful. The hunt will last from six to eight months.

DALE CONDIT, of Oil Search Ltd., Sydney, has been vacationing in England and is at present stopping over in Los Angeles before returning to Australia. He is accompanied by Mrs. Condit.

CHARLES HART, former U. S. Minister at Teheran and official of Amiranian Oil Company, is due in Baghdad, Iraq, September 15th en route to Teheran, Iran.

Colin McKinon, warehouse; Johnny Veal, driller; Nils Matheson, now representing Petroleum Machinery Corporation in London, England; and Martin Hess, drilling superintendent, snapped at Vega Oscura wildcat of British Controlled Oilfields, Ltd., in Eastern Venezuela.



A striking landmark on the Sidcup By-Pass, Kent, England. The modern factory recently erected by Richard Klinger, Ltd., manufacturers of Klinger gaskets, brake linings, etc.

BRITISH OIL IMPORTS

BRITISH IMPORTS of petroleum and its products during July, 1937, were slightly below those of the corresponding month of last year. The decline included all major products except lubricating oil.

British Oil Imports By Products

	July 1937	7 Mos. to July, 1937 (In Barrels)	7 Mos. to July, 1936
Gasoline	3,617,000	24,025,000	21,504,000
Kerosene	387,000	3,451,000	3,336,000
Gas oil	156,000	2,229,000	1,844,000
Fuel oil	1,659,000	11,330,000	10,724,000
Lubricating oil	335,000	1,911,000	2,024,000
Other sorts	1,000	180,000	252,000
Refined products	6,155,000	43,126,000	39,684,000
Crude oil	1,848,000	8,779,000	9,045,000
TOTAL IMPORTS	8,003,000	51,905,000	48,729,000

NEW LIFE FOR OLD FIELD

FOR THE FIRST TIME since 1917, a gusher was struck in the Bradford district, Pennsylvania—probably the largest in the history of the field. The well came in on August 24th, and about 2,000 bbl. had been lost when, after 14 hours, the crew was able to cap it. Flow was at first estimated at 240 bbl. hourly but later revised to from 13 to 17 bbl. per hour. As Bradford crude brings from $2.80 to $2.85 the well is estimated to be worth about $900 per day. Drilling was by Niagara Oil Company (Forest Oil Company), reaching the second Bradford sand at 1,629 ft.

B.P.M. GUSHER IN SUMATRA

N.V. DE BATAAFSCHE PETROLEUM MAATSCHAPPIJ is drilling to prove the existence of a new pool at its Rantau field, near Kwala Simpang, in Atjeh, Sumatra, where a 3,500 bbl. gusher was brought-in last December. At the time the well flowed wild and the oil was saved only by conducting it into drainage canals of a neighboring rubber estate. It was capped a week later.

U. S. OIL EXPORTS

	Jan.-June, 1937		Jan.-June, 1936	
	Barrels	Dollars	Barrels	Dollars
Crude oil	28,442,481	40,372,370	22,621,044	28,785,917
Gasoline	14,148,289	37,198,583	10,795,236	27,194,552
Kerosene	3,879,651	9,254,040	2,919,270	6,795,674
Gas & Fuel oil	19,401,786	24,341,581	15,648,032	17,519,786
Lubricating oil	5,137,686	39,606,362	4,337,839	32,422,392
Total	71,009,893	150,772,936	56,321,421	112,718,321

PASSENGER-TANKER FOR Y.P.F.

YACIMIENTOS Petroliferos Fiscales, Argentine government oil company, recently decided to construct another large tanker, the present fleet being considered insufficient. She will be somewhat similar in design to the recently-built 13 DE DICIEMBRE (10,000 tons d.w.) and will cost 5,406,000 Argentine pesos. The order was placed with Blohm and Voss. Like all the ships of the company's fleet she will carry passengers, accommodations being made for 36 in first class and 28 in third, or 16 more than the 48 carried by the 13 DE DICIEMBRE. Her dimensions will be 544 ft. 7 ins. length, 61 ft. 7 ins. breadth, 34 ft. 11 ins. depth, and 25 ft. 6 ins. loaded draft, with a displacement of 18,500 tons. Cargo tanks will have a capacity of 10,500 tons while a 21,186 cu. ft. dry-hold will be provided. Fuel oil bunkers will amount to 600 tons, boiler feed water 300 tons, and other supplies, 80 tons. She will have triple expansion engines of 7,000 i.h.p., powered by four cylindrical boilers, giving a loaded service speed of 13 knots and 15 knots on her trials, in April, 1938.

GULF EXPORT PRICES FOR MAJOR OIL PRODUCTS

Products		July 14	July 21	July 28	August 4
		Cents per Gallon			
GASOLINE:	U. S. Motor	6.06	6.06	6⅛	6⅛
	64 66-375 E.P	6⅜	6⅜	6⅜-½	6⅜-½
	59 Octane and below	6	6	6⅛	6⅛
	65 Octane and above	6½	6½	6½	6½
AVIATION GASOLINE: (Based on last actual transaction)	Gulf Export in cargo lots	9	9	9	9
KEROSENE:	44 w.w	5	5	5	5
	44 /43 w.w	4⅞	4⅞	4⅞	4⅞
	41 /43 p.w	4⅞	4⅞	4⅞	4⅞
GAS OIL:	26-30 translucent	4	4	4	4
	30 plus translucent	4⅛	4⅛	4⅛	4⅛
		Per Barrel			
FUEL OIL:	Bunker C	$1.05	$1.05	$1.05	$1.05
	Cargo lots	95	95	95	95
	Diesel oil	1.90	1.90	1.90	1.90
		Cents Per Gallon			
LUBRICATING OIL:	Bright Stock No. 8	30½	28½	28½	28½
	Bright Stock No. 6½	30	28	28	28
	600 Warren E	26	25	25	25
	600 Unfiltered s.r	22½	21½	21½	21½
(New York Export Market)	650 Unfiltered s.r	25	24	24	24
	600 Flash s.r	26	25	25	25
	630 Flash s.r	30	29	29	29
	Neutral 200 No. 3	33	32	32	32
	Neutral 150 No. 3½	28½	27½	27½	27½
(South Texas Export Market)	Red oil 500 No. 5-6	8½	8½	8½	8½
	750	9¼	9¼	9¼	9¼
	1200	9¾	9¾	9¾	9¾
	Pale oil 500	8½	8½	8½	8½
	750	9¼	9¼	9¼	9¼
	1200	9¾	9¾	9¾	9¾
		Cents Per Barrel			
CRUDE OIL:	East Texas delivered at Gulf for export	$1.55	$1.54	$1.54	$1.54
	Venezuela	$1.30	1.30	1.30	1.30
	Trinidad	.90	.90	.90	.90
	Panuco	1.35	1.35	1.35	1.35

FREIGHT RATES

	July 14		July 21		July 28		August 4	
	Dirty	Clean	Dirty	Clean	Dirty	Clean	Dirty	Clean
	Shillings per ton							
Gulf—U.K. /Continent	28/6	27/6	25/-	27/6	29/-	26/-	27/-	30/-
California—U.K. /Continent	—	—	33/-	34/-	—	—	—	—
Aruba—U.K. /Continent	22⅝-	24/-	21/-	23/-	21/-	23/-	21/-	24/-
North Atlantic—U.K. /Continent	23/-	24/6	23/-	24/-	23/-	24/-	23/-	24/-
	Cents per barrel							
California—North Atlantic	no booking							
Gulf—North Atlantic	50½	60	42	48	35	45	35	41
Venezuela—North Atlantic	49	—	35	—	37	—	37	—
Tampico—North Atlantic	53	—	41	—	40	—	40	—
Curacao—North Atlantic	—	—	34	—	34	—	36	—

WORLD OIL PRODUCTION—Official Figures

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in U. S. Barrels—Conversion ratio 7 bbl. = 1 ton)

Country	August 1936	September 1936	October 1936	November 1936	December 1936	January 1937	February 1937	March 1937	April 1937	May 1937	June 1937	Provisional Figures July 1937
United States	95,090,000	90,972,000	95,795,000	91,018,000	97,652,000	98,567,000	93,173,000	106,724,000	104,979,000	110,911,800	105,812,000[11]	106,314,000
Russia[1]	15,737,500	14,936,600	16,118,900	16,019,700	16,412,900	15,476,300	13,247,500	15,273,300	15,749,300	17,409,000	16,250,000[11]	15,200,000
Venezuela	14,632,737	14,626,073	13,888,287	14,307,650	8,452,626	9,888,298	13,583,024	15,584,002	15,192,324	16,032,625	16,820,370	17,036,131
Roumania	5,585,000	5,254,000	5,224,000	4,982,000	5,050,000	4,768,000	4,217,000	4,595,000	4,412,000	4,494,000	4,151,000	4,350,000
Iran[2]	5,117,000	4,487,000	4,704,000	4,620,000	4,963,000	5,250,000	4,417,000	5,866,000	5,768,000	5,789,000	6,153,000	6,100,000
Netherland India	3,715,887	3,731,973	4,059,426	4,139,954	4,190,578	4,267,148	4,011,266	4,405,436	4,348,185	4,553,298	4,464,725	5,208,460
Mexico	3,773,503	3,768,855	3,235,224	3,204,007	4,259,733	4,233,635	3,922,929	4,307,952	4,249,838	3,387,950	3,338,311	3,848,000
Iraq[3]	2,479,428	1,881,782	2,097,564	2,214,954	2,207,954	2,476,698	2,240,119	2,542,883	2,501,772	2,578,401	2,200,254	2,418,101
Colombia[4]	1,553,606	1,575,273	1,600,288	1,537,683	1,641,636	1,668,490	1,617,441	1,622,226	1,660,469	1,678,580	1,724,173	1,682,102
Peru[5]	1,527,072	1,478,482	1,507,433	1,445,605	1,492,023	1,448,545	1,321,989	1,464,979	1,412,094	1,435,796	1,412,678	1,284,588
Argentina	1,293,283	1,323,730	1,306,784	1,356,396	1,356,396	1,355,029	1,237,459	1,317,000[11]	1,267,000[11]	1,270,000[11]	1,278,000[11]	1,280,000
Trinidad	1,108,969	1,126,420	1,179,611	1,154,093	1,231,365	1,263,456	1,157,408	1,287,097	1,301,260	1,351,198	928,752	1,377,547
British India	815,415	791,217	730,860	778,617	809,218	757,936	756,857	803,327	688,000[11]	730,000[11]	750,000[11]	765,000
Bahrein[6]	780,265	422,799	209,086	419,643	619,910	730,064	549,260	799,994	659,557	432,748	684,348	695,000
Poland	301,000	294,000	301,000	294,000	301,000	295,400	273,000	292,600	294,000	294,000	287,000	290,000
Brunei[7]	275,310	257,040	294,070	294,560	322,210	354,480	327,600	357,630	333,410	343,310	320,810	324,310
Germany	257,859	255,556	277,158	265,650	279,545	265,531	233,366	245,007	249,088	247,100	251,482	249,046
Japan[1]	221,139	207,260	200,528	202,385	212,326	219,410	194,037	207,423	198,898	206,544	200,092	208,000
Ecuador	160,914	158,857	168,892	163,870	175,918	180,058	160,675	180,727	181,352	189,658	182,711	186,175
Sarawak[8]	129,150	122,010	127,330	122,920	128,240	125,440	114,380	125,650	119,770	123,480	120,820	131,670
Canada[9]	139,789	135,623	137,004	129,152	139,701	141,078	153,906	175,575	188,014	192,845	209,181	211,000
Egypt[10]	102,620	98,812	102,109	97,755	98,672	99,589	86,842	93,499	89,544	97,146	98,091	99,253
France[11]	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	41,034	45,000	45,000	45,000
Others[11]	56,000	50,500	47,000	42,000	38,000	37,000	40,000	39,000	43,000	45,000	44,000	42,000
Total	154,898,446	148,000,862	153,356,554	149,155,194	152,178,951	153,913,585	147,281,058	168,355,307	165,926,909	173,797,979	168,294,230	171,243,483

[1]Russian Sakhalin included with Russia.— Japanese Sakhalin included with Japan. [2]Anglo-Iranian Oil Company Ltd. figures revised; fuel oil returned to ground has been deducted. [3]Iraq Petroleum Company Ltd. export figures. [4]International Petroleum Company figures. [5]International Petroleum Company and Lobitos Oilfields Ltd. figures. [6]Bahrein Petroleum Company Ltd. figures. [7]British Malayan Petroleum Company Ltd. figures. [8]Sarawak Oilfields Ltd. figures. [9]Includes natural gasoline production. [10]Anglo-Egyptian Oilfields Ltd. figures. [11]Estimate.

Official Crude Oil Production Figures for 1932 to 1937

Country	Daily Average to July 31 1937	Daily Average 1936	Total to July 31 1937	Total 1935	Total 1935	Total 1934	Total 1933	Total 1932
United States	3,429,895	3,001,410	727,048,800	1,098,516,000	996,596,000	908,065,000	905,655,000	785,159,000
Russia	516,487	523,754	110,505,400	191,694,100	176,688,100	168,648,700	149,311,000	149,725,000
Venezuela	491,211	438,844	104,136,774	160,617,095	153,932,614	140,784,804	121,052,354	119,597,337
Roumania	146,165	173.587	30,987,000	63,532,846	61,270,072	61,849,306	53,919.708	53 651,978
Iran	185,580	156 794	39,343 000	57,386,833	52,413,879	52,761 604	49,606,942	45,120,656
Netherland India	147,447	131,043	31,258,518	47,961,744	45,307,913	45,107,828	41 234,498	37,988,913
Mexico	128,719	112,098	27,288,615	41,027,915	40,240,563	38,171,946	34,000,830	32 805,496
Iraq	79,991	76,711	16,958,228	28,076,167	25,733,839	7,214,216	1,018,290	818,300
Colombia*	54,969	51,246	11,653,481	18,756,110	17,617,645	17,340,724	13,157,127	16,834,956
Peru	46,087	48,068	9,780,669	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Argentina	42,427	42,294	8,994,488	15,479,692	14,317 500*	14,045,652*	13,759,565*	13,166,900*
Trinidad	40,875	36,167	8,666,718	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
British India	24,764	25,980	5,251,120	9,508,903	9,218,925	9,200,072	8,743,115	8,817,315
Bahrein	21,866	12,690	4,550,971	4 644,635	1,264,807	285,072	31,977	902
Poland	9,504	10,576	2,026,000	3,871,000	3,902,000	4,012,000	4,174,000	4,220 000
Brunei*	11,139	8,667	2,361,550	3,162,040	3,162,614	2,673,041	1,963,661	1,233,925
Germany	8,116	8,503	1,730,620	3,112,200	2,991,300	2,222,500	1,670,200	1,607,900
Japan	6,714	6,568	1,434,404	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
Ecuador	5,897	5,252	1,261,356	1,922,215*	1,731,785	1,636,619	1,619,902	1,597,641
Sarawak*	4,061	4,253	861,210	1,556,660	1,811,297	1,948,044	2,289,472	2,274,043
Canada	5,946	4,110	1,271,599	1,504,287	1,447,204	1,410,895	1,145,333	1,044,412
Egypt	3,132	3,395	663,964	1,242,437	1,235,052	1,502,697	1,627,157	1,855,392
France	1,467	1,562	311,034	534,063	529,664	700,000	786,366	755,146
Others*	1,367	1,352	290,000	495,000	539,000	612,000	532,000	503,000
	5,413,826	4,884,924	1,148,635,519	1,787,835,113	1,642,994,948	1,509,274,301	1,431,622,580	1,300,487,037

*Not officially revised.

JAPANESE National Petroleum Policy

By Morio Otaki

JAPAN'S national fuel policy is based upon the fact that the Empire supplies only about 10 percent of its petroleum requirements and might be seriously embarrassed in the event of a national emergency. Annual petroleum consumption in Japan amounts to approximately 24,000,000 bbl. exclusive of naval requirements. Only about 2,400,000 bbl. of this amount is supplied from domestic sources. Some 90 percent of the demand must be imported. These annual imports are valued at $37,700,000 at the current rate of exchange.

The four main keys to Japanese national oil policy may, therefore, be said to be: 1. Increased domestic production of petroleum; 2. development of subsidiary sources of supply, such as coal liquefaction, shale oil distillation and the use of petroleum substitutes; 3. Securing and assuring outside sources of supply; in other words to secure control of foreign production so located that there would be reasonable assurance that channels from this source to Japan could be kept open in any predictable national emergency; 4 To keep on hand stocks of petroleum sufficient to meet any temporary emergency, or at least to furnish supplies until other sources could be opened up.

To obtain the objectives outlined above, a national fuel policy was presented to the government in 1936 and a Bureau of Fuel was established in the same year.

The national fuel policy drafted by Ministry of Commerce and Industry for government consideration in 1936 called for the positive development of oil fields in Japan proper and colonies by (a) Increase of encouragement funds for prospecting of domestic oil fields; (b) Completion of scientific (including chemical) measures for research relating to discovery of new oil fields; (c) Subsidies to prospecting of colonial oil fields as well as their preliminary exploration. The fuel policy also embodies encouragement of fuel substitutes by (a) Enactment of a Substitute Fuel Industry Encouragement Law; (b) Encouragement of mixing of alcohol in gasoline, (enactment of a special law for compulsory mixing is considered necessary); (c) Prohibition of "cruising" by taxis to encourage rationalization in fuel consumption; (d) Expansion of the National Fuel Research Institute.

Of those items, the proposed Substitute Fuel Industry Encouragement Law is specially noteworthy. It is reported that the law provides for subsidies to substitute fuel industries such as coal liquefaction, low temperature carbonization, synthetic gasoline, etc.

The organization of the proposed Bureau of Fuel as indispensable machinery for carrying out the nation's fuel policy was decided upon by the Ministry of Commerce and Industry in 1936.

According to the ministerial plan, the Bureau of Fuel placed under its direct control practically all the activities of the different fuel research organs in the Empire, including the Section of Fuel in the ministry and the National Fuel Research Institute.

Two cardinal objects of the new Bureau are; first, the stabilization of the substitute fuel industry and second, the establishment of an alcohol monopoly by the government based upon the compulsory use of alcohol as fuel.

A special appropriation totalling $2,900,000 will be set aside by the government for the first year expenditures.

In pursuit of the national petroleum policy Japan spent in 1936 a total of $1,295,140, divided as follows: compensation for oil storage, $765,600; subsidy for prospecting in North Saghalien, $365,700; general prospecting subsidies, $81,200; subsidy for low temperature carbonization of coal, $27,550; oil field surveys, $16,240; research funds for liquefaction of coal, $19,720; research on synthetic gasoline, $3,190; research on charcoal gas producer, $24,940.

The oil fields of Japan are located in Hokkaido province which produced in 1935, 84,203 bbl. of crude; in Akita province which produced the same year, 1,428,840 bbl.; in Niigata province which produced 657,100 bbl. There are also small fields in Nagano, Yamagata and Shidzuoka provinces which together produced 415 bbl. in 1935. The production of crude in Taiwan in 1935 amounted to 41,770 bbl. In North Saghalien, controlled by the Japanese under concession from the Soviet Union, annual production in 1937 is expected to be approximately 1,837,500 bbl. of which 1,610,000 bbl. will probably be shipped to Japan.

The effect of government subsidies and the prospect of profits from domestic production is illustrated by a recent announcement from the Japan Oil Company, one of the large producing companies in Japan. This company has announced an extensive drilling program with the object of developing unproductive oil fields under its control. The present program includes large-scale drilling works at wells which were once abandoned as being hopeless. According to the announced plan, drilling activities will be either newly started or resumed at 41 wells in 25 oil fields owned by the company in Japan proper, Hokkaido, Formosa and the Japanese Saghalien. Of these, eight wells will receive government subsidies.

In a positive endeavor to encourage the exploitation of oil fields in North Saghalien, the Japanese government recently drafted a five-year extension subsidy plan. The $5,173,600 appropriation to cover the expenditures for the present plan including $3,723,600 in the form of subsidies and $1,450,000 in the form of the guarantee for the North Saghalien Oil Company debentures was demanded and approved in the 1937-38 national budget. In connection with the grant of the subsidies, government experts made a survey of the estimated crude oil production in North Saghalien by the North Saghalien Oil Company and the possible shipments of such crude to Japan proper. Estimated government figures of the North Saghalien crude production and shipments show that by 1941 production in Saghalien will be 3,222,800 bbl., and of this quantity, 2,555,000 bbl. will be shipped to Japan.

The North Saghalien Petroleum Company then announced a five-year extension plan in connection with the drilling of new wells in the oil fields which the company leases in North Saghalien from the Soviet government. The decision of the company on one of the largest-scale drilling plans ever undertaken by Japanese oil companies followed the successful negotiations concluded in 1936 between the Soviet government authorities and Vice Admiral Masazo Sakonji, President of the North Saghalien Petroleum Company, relating to the extension of the company's lease on the Soviet oil fields in North Saghalien. Admiral Sakonji succeeded in obtaining the consent of the Soviet government to a five-year extension of the company's lease, which was to expire by the end of 1936 according to the original agreement. The present drilling plan calls for an annual expenditure of $5,800,000 over the period of five years beginning in 1937. The company expects to raise the five-year expenditures totalling $29,000,000 either by collecting unpaid share capital, by increasing the authorized capitalization or floating debentures. According to the present plan,

(Continued on page 76)

JAPANESE STATISTICS

Area: (Japan proper) 148,756 sq. miles. (Japanese Empire) 263,359 sq. miles. Population: (Japan proper) 69,254,148. (Japanese Empire) 99,456,262. Inhabitants per sq. mile: (Japan proper) 405. (Japanese Empire) 378.

Principal Industries: silk, cotton, coal, china, paper, leather, rubber, pottery, matches, glass, iron, silver, copper, sulphur, rubber goods, cars, electric bulbs, bicycles, chemicals and shipbuilding.

Railways, length 13,931 miles; locomotives, 5,088; passenger carriages, 14,896; freight cars, 76,481. Traffic: passenger miles, 14,091,980,000; freight miles, 6,860,-300,000; number of passengers, 1,208,800,-000; tons of freight, 83,900,000.

Roads: 589,000 miles.

Motor vehicles: passenger cars and buses, 82,775; trucks, 52,084; motor cycles, 26,000.

Air craft: commercial air lines air craft, 56; civil aircraft, 91.

Ships: oil burning steamers, 97, tonnage, 564,317; total steamers, 1,437, tonnage, 3,253,644; motor ships, 709, tonnage, 832,006. Total all ships, 2,146, tonnage, 4,085,650.

Tankers: steamers, 8, tonnage, 55,948; motor ships, 12, tonnage, 94,243.

Retail oil prices and taxes (U. S. cents per gallon): first grade gasoline at service station, including a duty of 3.5 cents and a tax of 1.4 cents, at Tokyo, 19.3 cents; at Yokohama, 17.0 cents; at Kobe, 18.2 cents: second grade gasoline at service stations, including a duty of 3.5 cents and a tax of 1.4 cents, at Tokyo, 16.2; at Yokohama, 15.0; at Kobe, 16.0. Aviation gasoline, including a duty of 3.5 cents but no sales tax, in tins at Tokyo, 22.7 cents; in bulk at the pump (no tins) at Yokohama, 30.0; at Kobe in bulk at the pump (no tins) 31.4 cents.

Lubricating oils, including a duty of 4.6 cents for each grade and applying to each city mentioned, at Tokyo is $1.05 for first grade, 91 cents for second grade, and 51 cents for third grade; at Yokohama, first grade is 85 cents, second grade is 47 cents, and third grade is 28 cents; at Kobe, first grade is 94.1 cents, second grade is 52.7 cents and third grade is 47.0 cents.

CRUDE OIL PRODUCTION 1932-1937

Year	PETROLEUM Barrels
1932	1,683,439
1933	1,504,412
1934	1,872,837
1935	2,294,878
1936	2,403,072
1937	2,450,610*

* Preliminary figures.

PRODUCTION OF REFINED OIL PRODUCTS 1933-1936

PRODUCT	1936	1935	1934	1933
	Barrels			
Gasoline	4,146,196	3,590,010	3,071,566	2,487,130
Kerosene	812,244	556,186	475,730	569,294
Fuel oil	3,568,314	2,900,484	2,616,176	1,963,714
Lubricating oil	1,475,780	1,490,922	1,388,318	1,202,998

CONSUMPTION OF PETROLEUM PRODUCTS 1933-1936

PRODUCT	1936	1935	1934	1933
	Barrels			
Gasoline	7,912,034	7,020,238	6,296,812	5,261,280
Kerosene	844,110	858,800	753,936	704,894
Fuel oil	9,889,760	9,942,870	7,597,198	6,572,758
Lubricating oil	1,604,600	1,506,290	1,283,002	1,102,428

PETROLEUM IMPORTS 1933-1936

CRUDE OIL:	Barrels
1933	14,595,450
1934	17,714,000
1935	21,874,700
1936	26,071,000
GASOLINE, REFINED:	
1933	2,912,236
1934	3,459,834
1935	3,754,990
1936	4,113,200
KEROSENE:	
1933	362,956
1934	551,666
1935	634,834
1936	472,792
LUBRICATING OILS:	
1933	149,386
1934	249,730
1935	282,726
1936	402,280
GAS OIL:	
1933	Nil
1934	Nil
1935	Nil
1936	4,746
FUEL OIL:	
1933	4,778,544
1934	5,181,276
1935	7,425,908
1936	6,699 318

PETROLEUM EXPORTS 1933-1936

		Barrels
GASOLINE:		
1933		133,566
1934		234,588
1935		324,762
1936		347,588
OTHER MINERAL OILS: (790-880 deg.):		
Total	1,604	129
KEROSENE:		
1933		145,996
1934		273,460
1935		332,220
1936		440,926
LUBRICATING OILS:		
1933		249,956
1934		355,046
1935		267,358
1936		273,460
GAS OIL:		
1933		154,810
1934		160,234
1935		277,528
1936		222,158
FUEL OIL:		
1933		10,170
1934		40,454
1935		94,694
1936		160,460

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY OF PETROLEUM

Oil and Gas Possibilities in N. E. Arkansas and W. Tennessee—W. P. Jenny, in OIL WEEKLY, vol. 86 (1937) No. 4, pp. 26-30.

From magnetic investigations, to a great extent supported by surface geological considerations, it appears that a number of gentle structures may be found in northeastern Arkansas and western Tennessee, worth testing for oil.

From the writer's investigations, it seems highly probable that a considerable thickness of Pennsylvanian may be encountered, especially within the central area of the Paleozoic trough. The Pennsylvanian has been the source of much of the early oil and gas in Oklahoma; it yields considerable gas in the western Arkansas Valley; in southeastern Illinois oil was first discovered in the Pennsylvanian and considerable production has been obtained from this formation. The Junction City and the Wamac pools in southwestern Illinois produce from this formation.

Below the Pennsylvanian we may expect the Chester (Mississippian), another good oil horizon, from which the greater part of the oil in Kentucky and southern Illinois has been produced.

Deeper possibilities lie in the Devonian and Ordovician formations, which are producing in Kentucky, Illinois, Ohio and Indiana.

There exists also a fair chance that some oil accumulation has taken place in the shallow Tertiary and Cretaceous sediments.

Origin of the Glen Rose Formation—H. D. Easton, Jr., in OIL & GAS JOUR., vol. 36 (1937) No. 8, pp. 20-22.

From a consideration of the geological features of the Glen Rose formation, with special application to Rodessa and Lisbon fields of northern Louisiana, it is concluded that this formation was initiated in an advancing sea which was at first clear enough to permit coral growths that were later covered with mud which is now shale. The sea subsequently cleared so as to admit renewed growth of coral or oolite, followed by another deposition of mud and so on alternately, (producing the stratigraphic facies which has suggested the term "Glen Rose alternating beds"). After this period of alternating deposits, the sea became a large, densely briny lake in which were deposited layers of anhydrite and gypsum.

The important practical point is that below the anhydrite there is a series of "coquina" of oolitic horizons that are or may be oil bearing. Hence these northern Louisiana fields are pretty much of a hit-or-miss proposition, from which it is concluded that no wildcat to Glen Rose depths should stop short of the base of the Glen Rose, and additional footage into the underlying Travis Peak would be justified. Not that one should advocate the idea of "never abandon a well without drilling 100 ft. deeper," but the history of the North Louisiana fields indicates that no Glen Rose test should be considered a failure unless and until all of the Glen Rose beds have been proven unproductive. Production can be found in any one of these main zones or (as in some portions of the Rodessa field) in "stray" sands not otherwise classified, even though all the other zones be barren. The recent establishment of production from a zone known as the "Mitchell sand" in Miller County, Arkansas, which converted Rodessa into the nation's first tri-state field, is an outstanding example of the potentialities of Glen Rose "strays."

PETROLEUM GEOPHYSICS

Abnormal Velocities in Sedimentary Beds in Eastern Utah—A. L. Smith and John H. Wilson, in GEOPHYSICS, vol. 2 (1937), No. 1, pp. 56-62.

Velocity determinations and refraction shooting in eastern Utah revealed some very high velocities, which are believed to be related to hardening of certain shaly formations due to some form of alteration or incipient metamorphism since deposition.

The point is of interest because in the interpretation of refraction data it is assumed that granite, limestone, salt, etc., have characteristic velocities. This assumption is unsafe in such a region as this, because sands or shales may acquire velocities that are normally characteristic of much more consolidated or crystalline material.

DRILLING

System for Cooling Hot Drilling Muds—Denis S. Sneiger, in OIL WEEKLY, vol. 85 (1937), No. 11, pp. 40-42.

An East Texas wildcat well below 6,000 ft. developed high temperatures that besides having destructive effects on the rotary hose and other surface equipment had a tendency to gel the mud fluid. For lowering the temperature of the fluid the operator designed a mud cooler consisting of a 20-ft. section of 4-in. pipe with a series of slots cut along the underside and mounted six feet above the settling tank. The fluid issuing from the slotted pipe falls over a series of baffles where it is subjected to the cooling action of a blast of air from an 84 in. fan operated by a steam turbine.

New German Drilling Accessories—Neubauer, in OEL UND KOHLE, vol. 13 (1937), No. 23, pp. 539-552.

When rotary drilling was first introduced into Germany the equipment used was naturally almost exclusively of American origin, or at least constructed on American models. Within a short time the German industry had gathered enough experience to make their own improvements on rotary drilling outfits and these improvements have found use in other oil producing countries. The author gives a long list, with illustrated descriptions, of German inventions in this field. Among the most important of these are devices that enable full use to be made of the Diesel engine as a prime mover in drilling; hydraulic drum brakes; shock absorbers for the table drive and drill stem, stem couplings; new forms of drilling bits that wear uniformly; means for orienting cores as taken from the well; well clinometers; automatic devices for controlling pressure on the bit and numerous other new ideas of larger or smaller importance.

Photoelectric Cell Applied to Locating Water Intrusions—H. Guyod, in OIL & GAS JOUR., vol. 36 (1937), No. 4, p. 50.

The photoelectric method of locating water intrusions is finding advantageous use in the Mid-Continent and Gulf Coast areas. In its present form this process is applied as follows: the well under examination is conditioned by filling it with mud fluid. The well is partly bailed out to induce an upward flow of the well liquid. The photoelectric equipment is then lowered into the hole; the construction of the equipment is such that the fluid is caused to stream between an electric lamp and a photoelectric cell. So long as the well fluid remains opaque (undiluted with clear water) no light from the lamp reaches the photoelectric cell. As the place where clear formation water is flowing into the well is approached the muddy fluid is diluted and light begins to cause the photoelectric cell to produce current. When the descending apparatus comes opposite the source of fresh water, the photoelectric cell registers a maximum flow of current; as soon as this point is passed the undiluted, opaque mud shuts off all light, and the electrical recording instrument at the surface immediately registers a minimum. The current-peak thus indicated shows the location where the formation water is intruding, whereupon suitable measures may be taken to shut it out. Some strikingly profitable results have resulted where accurately placed cement has provided a seal that shuts off water which was preventing a large potential of high gravity oil from entering the well.

Standard Practice for Field Testing of Drilling Fluids—C. E. Reistle, Jr., G. E. Cannon and R. C. Buchan, before AM. PETROL. INST., Colorado Springs, June, 1937.

The successful completion of wells drilled to deeper horizons where high gas and water pressures may be encountered necessitates careful preparation and control of the drilling fluids. The prerequisite of proper mud control is the accurate determination of the various mud properties in order that desirable characteristics can be built into the drilling fluid. In the past operators have used numerous methods and apparatus to determine individual properties of mud; and each has, in most cases, selected for his own use some one test for each mud property. In discussing mud properties, the lack of standard tests makes it difficult to correlate or understand the results obtained with varying types of mud in different areas and by individual operators.

In an effort to standardize the methods of testing muds, the Houstin Chapter of the Institute's Division of Production made an extensive study of the subject, and proposed a standard on methods, instruments, and nomenclature for testing rotary-drilling fluids. Although this work stimulated standardization in that area, it has not resulted in a general standardization throughout the industry.

The subject of standardization of mud tests, with particular attention to field testing, was studied by the Division of Production's Topical Committee on Drilling Practice at the Chicago meeting in November, 1936, and a tentative code was adopted. It is possible to standardize the tests for determining mud weight, viscosity, gelation, sand content, and acidity and alkalinity.

The authors have accordingly presented a tentative standard for the determination of the five mud properties listed above.

Results of Logging Two Wells According to Drilling Speeds—G. C. Maddox, in OIL & GAS JOUR., vol. 36 (1937), No. 7, pp. 36-37.

The author calls attention to the possibility of obtaining useful correlations by taking note of the actual times consumed in drilling through certain formations. The idea is that "soft spots," especially in dolomites and limestones, are likely to be producing horizons, and that such soft spots reveal themselves by the rate at which they are penetrated by the drill. Further, in offset wells the same formations will be drilled at somewhat similar speeds, hence the logs of drilling speeds in different wells will add to the general information of the actual structure and possibilities of the field.

Possibilities of the idea are illustrated by logs of two wells in the Moore (Pa.) pool, which prove the value of the method. Numerous correlation points were disclosed; "markers" were found by the drill that had not been noted in the samples and some which are not revealed at all by the samples.

On the other hand the samples show some markers which do not affect the drill; of course there are markers easily noted by both the samples and the drill. When both are taken together the work is a great aid in quickly establishing a type section with correct intervals and thicknesses, which will be particularly valuable in both stratigraphical and structural work in a new pool. The author is even of the opinion that the method might accomplish the same results on the first two wells in a pool that would be usually accomplished by the "soaking in" method on 30 wells, or when the pool is relatively old.

The method of obtaining the data is simple: the driller is furnished with a pack of sample envelopes on which he records drilling changes and drilling time in terms of feet per hour.

Drill Pipe Failures Due to Faulty Design—J. E. Brantly in WORLD PETROLEUM, vol. 8 (1937), No. 6, pp. 66-71.

With the transition of petroleum drilling operations from shallow to deep wells the question of strength and resistance of metals has assumed greater importance, particularly as regards the durability of drill piping. Statistics indicate that in the United States some 4,000,000 ft. of drill pipe are rendered useless during a year, representing an unsalvaged value of over $12,000,000. The number of fatigue failures is roughly estimated at 6,000 a year, costing an average of $300 each, in some cases running much higher in difficult areas.

Principal points at which failure occurs appear to be in the root of the thread on the ordinary drill pipe, and in the normal tube generally near the beginning of the upset; thread failures caused by metal fatigue are much more common than in the body of the pipe. One answer to the problem of thread failure may be found in welding. However, welding has not yet had a fair trial and it is not definitely known to what extent pipe failures might be avoided thereby. Pending the settlement of this question much might be accomplished by a change in drill pipe design that will avoid too rapid changes in cross-sectional area; recent investigations have shown that rounded thread grooves are less subject to fracture than threads that have a sharp V-groove. Additional strength is conferred if the round thread grooves are rolled to fill any fine cracks or scratches left by the cutting tool. An additional weighty suggestion is to have the tool joint box and pin as integral parts of the pipe; one tube manufacturing company is now furnishing such a joint. Other sources of pipe failures are phosphorus banding in rolled plates or by inclusions of slag or scale; high carbon streaks are equally effective.

Where the shrink grip principle of attaching tool joints to drill pipe is used, caution in design and practice must be exercised to avoid shrinking the tool joint onto the pipe with too great a difference in diameter sizes.

Problem of Higher Surface Pressures from Deeper Drilling—Herbert Allen, in OIL & GAS JOUR., vol. 36 (1937), No. 6, pp. 71-75.

Development of unprecedented surface pressures in deep wells of the Gulf Coast has forced a reconsideration of drilling and completion practices in known high pressure fields. The first and most obvious move in this direction is the use of hook-ups tested to 5,000 or 6,000 lb. pressures and a new type of casing-head which makes possible quick suspension and sealing of the casing on very short notice, and also to permit suspension and sealing should the pipe string become stuck. A new type of wire line blowout preventer has also made its appearance.

One of the most interesting and unique proposals has its origin in the necessity for a quickly available source of high-pressure mud for killing completed wells or controlling drilling wells should fittings cut out, or should other exigencies make this course compulsory. The plan is to install a central mud-mixing and high-pressure circulating system in the Old Ocean field. The nucleus of the system will be a special 15-in. by 4½-in. by 18-in. slush pump. The pump will circulate synthetic mud mixtures to any part of the field at approximately 6,000 lb. pressure, having a displacement of 100 bbl. an hour at 40 strokes per minute. Other units of the system include 200-lb. working pressure steam boilers, boiler feed pump, water pit, pickup and mixing pump, mud mixing equipment, mud pit, mud storage warehouse, necessary connecting lines and a manifold ready for quick connection to any well in the field. Completed wells are now being equipped with hydraulic lines leading out 50 ft. from the christmas-trees, so that in event of need a hydraulic line from the central high-pressure circulating system may be laid quickly and tied in to the well.

The soundness of this plan is clearly demonstrated by an incident which occurred recently in a high-pressure wildcat completed near Galveston. For reasons unknown the well began making considerable sand and before the lease men were aware of the seriousness of the situation one of the fittings on a tubing flow-wing, located behind the control valve, cut out. By that time all of the control valves had been so seriously sand-cut that the well pressure could not be held. In less than an hour the well was loose, and involved a hazardous and costly capping job. Had it been possible to pump heavy mud into this well as soon as the danger of the situation was discovered, the loss of control would have been avoided.

Resistance of Seamless Drill Pipe Against Collapsing Pressure—Mannesmannrohren-Werke in OEL UND KOHLE, vol. 13 (1937), No. 23, pp. 536-538.

The sinking of very deep wells involves the problem of providing pipe that will support the pressure of a tall column of water outside the pipe in case there is no column of water of equal height inside. The formulas heretofore in use for calculating the collapsing pressure of pipe have only an empirical basis and are valid only for certain limits of tensile strength, as 78,000 to 92,000 lb. per sq. in.; that is to say, the yield point of the steel has been left out of consideration, so that the higher strengths of new steels is not properly represented.

The Mannesmannrohren-Werke has developed two new formulas, and has checked their applicability by extensive tests. These formulas are:

(1) $P_k = 2\,E \left(\frac{s}{D}\right)^3$ for the elastic range,

(2) $P_k = Q_s \left(2.63\frac{s}{D} - 0.043\right)$ or the yielding range.

In these formulas:

P_k = critical external pressure in (metric) atmospheres,
E = modulus of elasticity 2,000,000 kg/cm²,
S = thickness of wall in cm.,
D = outside diameter of the tube in cm.,
Q_s = yield point in kg/cm².

Both these formulas should be applied, and the one giving the lowest value should be accepted as governing the particular case. Examples are given of calculations based on nomographs involving wall thickness, outside diameter and critical external pressure, thus:

1. If an 8⅝-in. A.P.I.-casing has an outside diameter D = 206,375 mm., a wall thickness s = 9,398 mm., find the critical external pressure for a number of different materials.

   The ratio $\frac{s}{D}$, being decisive for the critical external pressure, the formula will read in this case:

   $$\frac{s}{D} = \frac{0.9398\ \text{cm}}{20.6375\ \text{cm}} = 0{,}045.$$

   If a perpendicular is plotted at $\frac{s}{D} = 0.045$, the critical external pressure lies at those points where this line intersects those representing the yield points of the various materials.

2. Basing upon a given depth of the well at a given specific gravity of the mud, the critical external pressure is fixed at 400 (metric) atmospheres.

   What is the thickness of wall of a 5¾-in. A.P.I. casing, if the material possesses a yield point of 50,000 lbs./sq. in.

   A horizontal line is drawn at P_k = 400 atmospheres through to the line representing the material with the said yield point, and from here the curve is drawn downwards vertically and $\frac{s}{D}$ found to be 0.06; since D = 5¾-in. equal to 14.605 cm., s = 0.06 X 14.605 = 0,875 cm.

OIL WELL OPERATION

Cleaning Oil Sands with Hot Air—F. R. Cozzens, in PETRO. ENG., vol. 8 (1937), No. 9, p. 55.

Cleaning oil sands with hot air has given good results in shallow-sand fields of southern Ohio. The pumping equipment is removed, a packer is attached to the end of a string of 2-in. insulated tubing, the annular space between tubing and casing is insulated with saw-dust or other suitable material and the tubing is connected with a source of compressed air at 300 deg. F.; injection is continued for 70 or more hours, or until the pressure at the casing head reaches 600 to 1,000 lb., whereupon the pressure is released and the sludge mud, melted paraffin, etc. is bailed out. A second or a third application may be necessary. In 80 percent of the cases, production has been increased 30 to 50 percent. Costs are $25 to $35 per well, as the insulated pipe may be reused.

Prolonging Sucker Rod Life by Elimination of Abuses—B. Mills, in OIL WEEKLY, vol. 85 (1937), No. 11, pp. 16-28.

This is an interesting and extensive account of the causes of sucker rod failure, due to a great variety of abuses and mismanagement that singly and collectively produce a large crop of annoyances and losses. Mistreatment of sucker rods occurs at many points and in great variety during transportation, running, pulling, and in pumping operations. Counter measures are trained crews, proper tools, knowledge of well conditions and strict rules for all phases of the handling of the rods.

Chief among the sins that are committed against sucker rods are use of inferior steel, overloading,

improper counter-balancing, improper make-up, and carelessness in hauling and handling that results in bending, kinking and mechanical injury. The care of sucker rods is on the whole an intricate art which must be learned by management as well as by crew, but when duly acquired by all hands may mean the difference between an average effective rod life of months rather than of weeks.

Disposal of Salt Water—F. L. Singleton in OIL & GAS JOUR., vol. 36 (1937), No. 6, p. 83.

In the English Bayou field near fresh water of the Calcasieu River, Louisiana, pollution from salt water is avoided by conducting the water of seven wells to a reservoir 180 ft. square which is adapted to hold water 3¼ ft. deep.

About 200 ft. of 2-in. pipe is supported about 12 in. above the salt water, on the surface of which impinge gas flames from ⅛in. holes bored every 30 in. of pipe length. The artificial heat supplied in this way is intended to supplement natural evaporation by the heat of the sun. For this purpose use is made of excess gas from producing wells that ordinarily would be burned off by flares. At the present time about 600 bbl. of salt water a day is being thus disposed of. What will eventually be done with the salt obtained by this relatively inexpensive evaporation process is not stated.

TRANSPORTATION

New Technique of Pipe Coating—W. H. T. Thornhill, in OIL & GAS JOUR., vol. 36 (1937), No. 6, p. 57.

A new machine and a new method of procedure was used in coating a 20-in. gas pipeline in Kansas. The pipe, cleaned and shop-coated at the mill, was received at a storage yard where it was again cleaned as required and passed through a new design of end-feed pipe coating machine wherein it received a hot coating of bitumastic 70-B enamel. After transfer from the coating plant to the job it was wrapped with an unbounded Johns-Manville coal-tar saturated pipeline felt. This separation of the coating job from the wrapping operation appears to be new in pipeline practice; no trouble was experienced from damage to the applied coating in the handling transportation or unloading in the field.

A further departure from the usual practice was that the coating of the entire pipeline was done on the job by the manufacturer of the pipe coating, who also attended to the coating of the joints in the field, employing for this purpose a separate and distinct organization. This method is considered to be of distinct advantage to the laying contractor, as it relieves him of all responsibility and attention to the proper coating of the pipe. The system of having a central coating plant avoids many of the annoyances from inclement weather and other disagreeable circumstances that arise at points on the laying job.

Progress in Pipeline Joint Construction—W. L. Baker, in OIL WEEKLY, vol. 86 (1937), No. 3, pp. 44-54.

Progress in pipeline construction practices was great during the past year, exceeding any recent 12-month period. Outstanding among the advancements were the greater speed with which joints of pipe are connected, several new methods of procedure in joining them, and greater joint strength.

Speed of installation is a prime requisite of any type joint, especially in the oilfield. It means lower installation cost in the end, and getting the line into service in minimum time—an important consideration when every day lost means added overhead, interest during construction, and loss of operating revenue. Remarkable speed, probably a world's record, was made in constructing a 300-mile crude oil line for Shell Oil Company from Bakersfield to Martinez, California. The line was constructed of 6-, 8- and 12-in. diameter pipe connected by plain butt joints, electrically welded without backing-up rings. The pipe ends were beveled to approximately 30 deg.

The high speed of construction on this line attests to the efficiency of the modern "firing line" method of pipeline welding. This method has no rival for speed. All the work is done practically as "straight-line" production. There is a crew for lining up the pipe, one for tack welding, and a third for the finish joint welding. They work in the order given. The finish welders come to each joint in a section with everything in readiness for being welded. The pipe is turned as the welding is done, permitting all welds in downhand position, best for speed and quality.

No record of welding of pipe lines for the past year would be complete without referring to the "stove pipe" method. Use of "stove piping" or "all-bellhole" welding increased during the year. In fact, this method has come into quite general use during the past two years, displacing the "firing line" or "storm gang" method on most of the shorter lines. "Stove piping" is particularly advantageous on short length lines, and through muddy country, or under other conditions that make it impossible to complete any great distance during a day.

Electric welding, first used in building pipelines in 1928, continues to be improved and to be used to a greater extent. One large pipeline contracting firm estimates that 75 percent of oil industry lines in 1936 were welded by this method, which is double the percentage used just three years ago.

Acetylene welding has made considerable improvements in equipment during the past year, too. Foremost has been the increased facilities for greater speed, which has consisted largely of more flames on the multi-flame torches. Work underway along these lines indicates that soon it will be possible to pour nearly twice as much metal as formerly.

Along with improvements in executing welded joints the manufacturers of the coupling type pipeline joint have made several improvements in their product particularly in the way of better gaskets, which resist any working pressure. One pipeline construction job finished in 1935 used 10,000 couplings. A recent query resulted in the answer that not a single coupling leak had developed to date, although maximum working pressures of 700 lb. per sq. in. have been used.

The speed with which coupled lines may be connected has also been advanced. It is said that, regardless of weather conditions, a 20-in. joint can be assembled by two men in 12 minutes.

Transportation of Oil—L. F. Scherer, in OIL WEEKLY, vol. 86 (1937), No. 3, pp. 32-38.

After reviewing the history of the five eras of oil transportation (by barge, truck, rail, tanker and pipeline), the author discusses the construction and operation of pipelines, organization of pipeline companies and forecasts the trend of the pipeline industry.

Today the industry operates more than 115,000 miles of pipelines, built at a cost exceeding $1,000,000,000. Development within the past few years has been rapid. The day of large construction programs has passed and the attention of pipeline engineers and executives is being shifted to planning for more efficient operation and ways of meeting approaching obsolescence and maintenance schedules.

Trend has been toward greater mechanization of construction methods and we may expect to see more development in this direction. Technique of welding is being improved and we may expect semi-automatic welding of pipe joints in the not-too-distant future.

Higher tensile strength seamless and electrically welded, plain end pipe in 30- to 60-ft. lengths and thinner walls is rapidly replacing the low carbon, lap-weld pipe of shorter length and greater unit weight in new pipeline construction. We may well expect further developments along this line.

Greater attention is being given to corrosion of underground structures and as our knowledge of the corrosive action and our practice in combatting it increases, we may expect great progress in this field of maintenance.

Every type of pumping equipment is being greatly improved upon. Old straight line steam field pumps are being replaced by modern reciprocating and rotary pumps powered by high-speed Diesel and gas engines especially designed for the service. Modern main line pumping plant is a far cry from the plants of even 10 to 15 years ago. There is a definite trend toward relatively high-speed compact units of lower first cost and lower installation costs that are still capable of maintaining a high degree of efficiency without undue increase in maintenance.

Refinements growing from scientific invention and research will be successfully applied to all forms of transportation of crude oil and this branch of the industry, economically so important, may be expected to keep pace with all other branches of the industry in the general advance.

NATURAL GAS

Malodorants for Fuel Gas—Michael J. Leahy, in OIL WEEKLY, vol. 86 (1937), No. 7, pp. 32-34.

The recently enacted Texas law (prompted by the disastrous explosion of leaked gas in the New London school) requiring the use of malodorants in all gas to be used for domestic fuel purposes puts many and serious problems before producers, transporters and marketers of natural gas. The first of these problems is the devising of means of mixing the malodorant as it issues from individual wells. This will require installation of thousands of units, and will include even cases where gas is taken from a single well for use in isolated lease houses. The most promising solution of this problem appears to be to place a small anemometer or tiny velocity turbine operating a needle valve which will control the flow of the malodorant into the gas line and would operate only when gas is flowing.

Another problem is selecting the proper point at which to feed malodorant in gas trunk lines serving towns and cities. The malodorants most likely to be used are mercaptans, which are organic sulphur compounds. Such compounds are corrosive and prolonged contact with the metal of the mains will result in the malodorant being largely retained by the metal before reaching the point of consumption. The law has also been interpreted as requiring malodorants to be placed in all gathering lines of any well that is delivering gas to a gasoline plant, so the gasoline from such plants will be "sour," which will add to the expense of doctor-treating.

The next problem will be that of obtaining sufficient supplies of suitable malodorants at reasonable prices. There are numerous substances with distinctive and penetrating odors, such as acrolein and tear gas, but nearly all are open to objection for one reason or another. Apparently the only chemicals that meet all requirements are the butyl and amyl mercaptans. These can be prepared by combining the appropriate alcohol with hydrogen sulphide. The hydrogen sulphide can be obtained in sufficient quantity from the high-sulphur natural gases of West Texas and the Panhandle. In any case facilities for manufacturing these mercaptans on the required scale are still to be provided.

REFINING

Evaluating Alloy Steel Tubes for Cracking Still Service—W. L. Nelson in OIL & GAS JOUR., vol. 36 (1937), No. 6, pp. 79-81.

Some refiners have been hesitant about adopting alloy steels for cracking still service because of the extra initial cost of such steels. All of the standard tube materials that are now offered by steel manufacturers are cheaper than carbon steels. They last much longer than carbon steel for even the normal condition in which no corrosion, except oxidation or scaling, occurs and for those extreme cases in which the oil is corrosive use of alloy tubes is even more advantageous. Neutralizing chemicals can be utilized to combat internal or oil corrosion and hence

we have only two major factors to consider in evaluating the usefulness or worth of a tube steel—namely, resistance to oxidation at high temperatures and strength at elevated temperatures. In general, the tube steels now offered are aimed at superior properties in these two respects although certain of the high chrome steels are also useful in combatting sulfur corrosion.

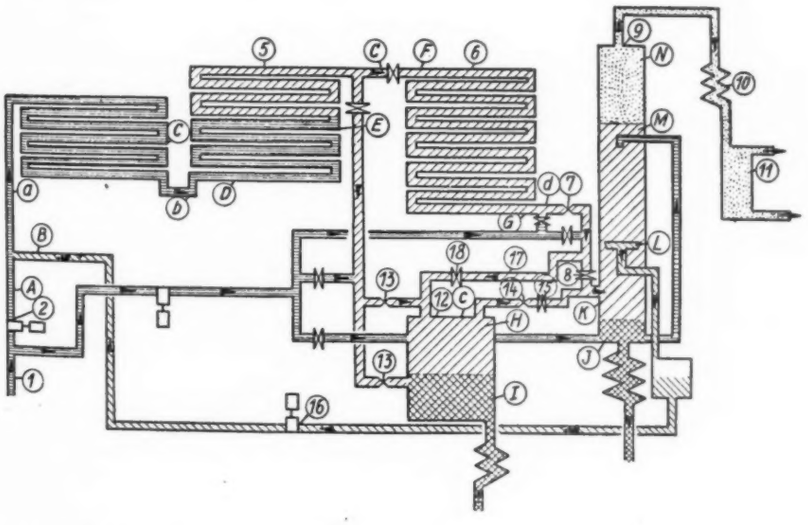
Three alloy elements, chromium, molybdenum and silicon have been found to be most useful in attaining scaling resistance and high temperature strength. Of these elements, molybdenum is detrimental to the scaling resistance but its great value in increasing the creep strength far outweighs its tendency to increase scaling.

Rates at which steels will scale or oxidize at high temperatures are now more or less well known, so that the lives of materials now available may be considered in connection with their costs. From such data it may be inferred that if a carbon steel will last for one month in a particular set of still conditions, one might expect that carbon moly steel would last over 5.5 months and that fine chrome moly silicon steel would last for 105 months or about nine years. It is interesting to note that although carbon moly steel scales more rapidly than carbon steel, it is so strong that six times as much metal can be lost by rusting as that lost by the carbon steel before the carbon moly must be taken from service. Thus, the carbon moly steel, because of its strength and in spite of its poor resistance properties, will last much longer than carbon steel. If the cost of maintaining carbon tubes in a still is $100.00 per month, the cost of maintaining Silmo tubes in the still for the same length of time is only $26.00 and for Croloy 3 tubes, only $20.00. In addition to this saving which is based only on the cost of the tubes, the carbon tubes would involve additional costs for frequent shutdowns and replacement.

Most of the special steels are also more resistant to sulphur corrosion than carbon steel.

Electrically Heated Experimental Cracking Plant—Leo Ubbelohde and F. Schlosser, in OEL UND KOHLE, vol. 13 (1937), No. 23, pp. 533-562.

For a more accurate and flexible means of studying the cracking of oils an experimental unit has been installed at the Berlin Technical High School in which electricity is used for heating the various units. In imitation of industrial practice the coil



banks are divided into three zones including (1) a preliminary heating zone, (2) a finish heating zone and (3) a cracking zone. Each of these zones is heated independently by including the tubes in the zone within an electric circuit. As it would be extremely difficult to insulate the three zones separately it was decided to use a triphase alternating current, each of the zones being heated by one of these phases, the current supplied to each phase being controlled by a regulating transformer. This sub-division of the apparatus permits various uses of it: as a simple tube cracking still; as an installation for tube cracking and retort cracking; and as an installation for compound tube cracking. This adaptability permits a wide range of comparison between different processes and methods of treatment, using only small quantities of oil. The apparatus is equipped with a full set of instruments for measuring quantities of oil, temperatures, pressures and specific gravities of both liquid and gaseous products.

The accompanying diagram represents the layout. A and B are points for measuring quantities, C to N are points for measuring temperatures and *a* to *e* are points for pressure observations.

The precision of work with this installation is illustrated by the following example: At a cracking temperature of 419 deg. C. an American gas oil that took 79 seconds to traverse the cracking zone gave a 0.23 percent yield of 150 deg. C. endpoint cracked gasoline; increasing the temperature to 460 deg. C. and the cracking time to 81.5 seconds. The gasoline yield was 1.6 percent. According to American authorities the cracked gasoline yield should be doubled with an increase of cracking temperature 14 deg above 450 deg. C. On this basis the expected increase in this experiment should have been 1.39 percent, whereas 1.6 percent was actually obtained; this is considered a very fair agreement.

Theory of Combination Selective Cracking—Eugene R. Smoley, Valentine Mekler and A. Henry Schutte, in WORLD PETROLEUM, vol. 8 (1937), No. 6, pp. 96-101.

The authors describe a four-coil unit consisting of a viscosity breaker coil, two gas-oil recycle coils operating on stocks of different boiling range, and a once-through gas oil or reformer coil. This design applies the principle of segregating cracking stocks according to refractivity; it is based on realization of the fact that recycle gas oil may be subjected to temperatures far higher than could be used for a virgin stock of the same boiling range. If such stocks are cracked in a mixture the operating conditions would be limited by the coke-forming tendency of the virgin material and the recycle stock would be undercracked. By cracking the two stocks separately higher yields of higher octane gasoline, lower recycle ratios and lower investment and operating costs result. This improved performance is obtained by operating each coil at a high crack per pass, or volume percent gasoline yield on heater charge.

The main feature of design in this process is the construction of the heater so as to make the most advantageous combination of temperature, pressure and soaking time to a given stock. The required flexibility is most suitably provided by placing the preheating and soaking tubes of the heater in separate and independently fired chambers. The oil first enters the convection section, then passes through the upper, lower and side wall tube banks of the preheating chamber and finally through the various tube banks of the soaking chamber. Uniformity of heat transfer is obtained by removing the furnace combustion products over the entire area of the roof, and also by firing from both ends of the heater parallel to the tubes. Operating figures are given which show results that have been obtained.

PETROLEUM CHEMISTRY

Cold Fractionation of Mineral Oils by the Use of Solvents—H. Steinbrecher and H. Kuhne in OEL UND KOHLE, vol. 13 (1937), No. 21, pp. 481-483.

The authors make a further exposition of their method for the quantitative analysis for separating a mineral oil mixture into the six main groups: creosotes, olefines, aromatics, cyclo-olefines, naphthenes and paraffins. The method was first applied to heavy distillates from brown-coal tars and is now being extended to solar (gas) oil, gasolines and cracked products.

The analytical procedure consists in first removing creosotes by a caustic soda wash. Then the olefines are removed by extraction with diethyleneglycol, the aromatics by extraction with diethyleneglycol, plus sulphur dioxide, the cyclo-olefines with alpha-alpha-dichlorohydrin, the napthenes with benzyl alcohol; the residual oil consists of paraffins.

This method is more discriminating than treatment with sulphuric acid and except in the case of the lowest, boiling distillates and crude oil is the most logical method for obtaining orienting information regarding the distribution of the various groups in the higher boiling crude oil distillates.

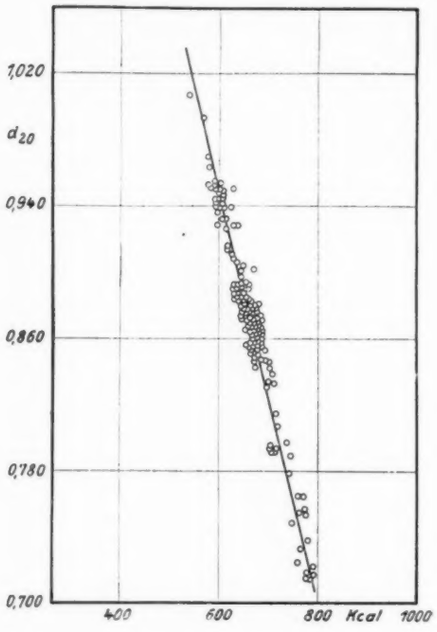
Studies on the Separation of Lubricating Oils by Means of Selective Solvents—H. Steinbrecher and H. Kuhne, in OEL UND KOHLE, vol. 13 (1937), No. 23, pp. 563-565.

In a previous work it was shown that petroleum distillates (except the lower-boiling gasoline fractions) may be separated into their main constituents —creosotes, olefins, aromatics, cyclo-olefines, naphthenes and paraffins—by cold fractionation with selective solvents; the accuracy of this separation is sufficient for disclosing the nature of a given product. However, the method cannot be applied directly for an orienting examination of a crude oil; to cover this case the authors have adopted the following procedure: the crude oil is first distilled under atmospheric pressure to remove all constituents boiling under 300 deg. C. The residue is then distilled with superheated steam as long as any oily product passes over, the temperature of the superheated steam being raised as high as necessary for the purpose. This leaves in the still an asphaltic resinous mass; the steam distillate contains all volatile hydrocarbons, including the vaseline and paraffin constituents. These latter are separated from the oil by the acetone method, and the oil is then in excellent condition for selective cold fractionation by solvents, using alpha-alpha-dichlorhydrin, benzyl alcohol and ehyl acetate, as described in the previous publication.

Simplification of Analytical Mineral Oil Tests by Density Measurements—Maxmillian Marder, in OEL UND KOHLE, vol. 13 (1937), No. 25, pp. 644-653.

It is universally known that the hydrogen content of mineral oils of the same boiling range decreases with increasing specific gravity, and that the hydrogen percentage also decreases with rising boiling point. On the basis of an extensive research the author has worked out a system for determining hydrogen and carbon contents, carbon-hydrogen ratios, available hydrogen and the upper and lower heat-values of mineral oils of different origins and boiling limits, using for this purpose a series of specially graduate aerometers (made by W. Bardewyck, Berlin-Baumschulenweg, Germany); such

aerometers are also provided for brown and stone coal products. In the estimation of carbon content and heat values of oils of medium boiling points a correction for sulphur content is applied, and also a correction for creosote content in the case of tar oils. On the other hand no correction is necessary when determining the hydrogen content, carbon-hydrogen ratio, and available hydrogen, nor is any correction necessary when determining the carbon contents and heat values of gasolines and lubricating oils by the aerometers.



In general, the accuracy of these aerometric determinations are within the limits required of the data obtained by the usual analytical methods, as is shown by the comparative figures presented in the paper. The accompanying graph shows the difference between the upper and lower heat values, in Kcal/kg, of petroleum products of different boiling points in dependence on specific gravity. The agreement between the calorimetric and aerometric heat values of an oil will not average more than plus or minus 10 Kcal/kg. Considering the great saving in time and trouble in this determination the aerometer may go a long way in substituting the calorimeter or the method of elementary analysis.

For a Dubbs-cracked oil use is made of the relations established for brown coal oil, whereas hydrogenated products and synthetic oils conform to the specific gravity relations of ordinary petroleum.

PETROLEUM PHYSICS

Extended Vapor-Pressure Charts for Hydrocarbons and Petroleum Products—E. S. L. Beale, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 23 (1937), No. 163, pp. 316-349.

The Boiling-Point Conversion Chart of Beale and Docksey has been extended to cover pressures above atmospheric for the estimation of vapor pressures in fractionating column calculations. A modification of the same chart is given to show how it can be used for adjusting the boiling point of residues from crude oil for small pressure changes, as is required in the calculation of equilibrium temperatures.

The pressure scale on the original chart was limited to 760 mm. mercury. It was therefore necessary to extend the pressure scale to include higher pressures as well as pressures below atmospheric. This has been done by the same method as used in the construction of the chart mentioned above—namely, by plotting the same and other available data first as a vapor-pressure—temperature chart on a scale of $\log p - \frac{1}{T° \text{ abs.}}$. The results from this chart were then cross-plotted in the form of a chart giving boiling point at p mm. against boiling point at 760 mm. From these charts the pressure scale can be extended up to the limit of the available data—namely, the critical pressure.

It is often necessary when estimating vapor pressures of fractions for column calculations to use a figure for the vapor pressure of fractions having boiling points at 760 mm. beyond the limits given on the previous chart, as this was confined to the range 100 deg. C.—700 deg. C. This scale has therefore been extended to cover the range—100 deg. C. to 1,000 deg. C. The nomograms and charts given in the paper provide for various cases.

Design and Analysis of Fractionating Columns for Complex Mixtures—P. Docksey, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 23 (1937), No. 163, pp. 316-349.

The problem of design and analysis of the performance of fractionating towers in which complex hydrocarbon mixtures are distilled has been approached in several ways.

In most cases the equilibrium between vapor and liquid is assumed to be perfect, and the tower is then considered to consist of a number of "theoretical plates" which can be reduced to actual plates from a knowledge of the plate efficiency. In one case—the method of Lewis and Wilde—the fact that the plate is not perfect is allowed for by the adoption of the Murphree efficiency in derivation of the equation. The resulting equation is excellent for analysis of plate performance if sufficient data are obtainable from the test on the tower.

Necessity of estimating the plate temperatures accurately during the course of the calculation is the reason for the lack of success to be attained in the application of the Lewis and Wilde method to design. This can be overcome by making use of the fact that the ratio of the vapor pressures of two hydrocarbons (that is, the relative volatility) is reasonably constant over a wide temperature range. Underwood extended the relative volatility ratio method to give an equation applicable to finite reflux ratios. He briefly shows how the equation may be used to give a workable stepwise calculation of the separation between overhead and residue in a stabilizing column in which the feed is correctly placed, and in which the separation between two components is relatively complete.

With this previous work as a basis the author has evolved a method applicable to what may be called continuous mixtures (in which the pure components cannot be distinguished). Special prominence is given to the case in which the separation is between two tray cuts and the analysis of fractionating powers to determine plate efficiencies.

ASPHALT AND TAR

Asphalt-Molasses Road Composition — H. D. Sen and K. C. Joshi, in JOUR, SCIENCE AND TECHNOLOGY INDIA, vol. 2 (1936), Nos. 1, 2, pp. 8-24.

Sugar cane molasses (a by-product available in fairly large amounts) has been experimented with as a road material, but except for very limited uses is disqualified by its solubility in water. However, it is known that substances containing aldehyde and ketone groups can be converted into insoluble resins by condensation with phenols. This succeeds very well with pure sugar, using sulphuric acid as the condensing agent but is a failure with molasses on account of the presence of organic impurities such as gums, pectins, caramels, etc. Experiment showed that the desired insoluble product could be obtained by intimately incorporating 70 lb. of dried molasses, 12.5 lb. of powdered quicklime and 52.5 lb. of asphalt (source and quality of asphalt not specified). It is necessary to dehydrate the molasses in a pot provided with a stirrer. When the mass has been boiled off to a suitable consistence the powdered quicklime is stirred-in (hydrated lime will not do), the asphalt follows next and after thorough incorporation of the ingredients the liquid mixture is run into shipping containers. Experimental roads made with this mixture in comparison with ordinary road asphalt have stood up satisfactorily. The cost (in Indian currency) per ton of the molasses-asphalt road tar is Rs. 60 as compared with Rs. 118 for road asphalt. This allows 8 annas per maund for the molasses, which gives the sugar factories a good return for this by-product.

This process is the subject of Indian patent No. 22,630 of 1936.

PETROLEUM SUBSTITUTES

Large-Scale Technology of Oil Synthesis from Water Gas—F. Martin, before SECOND WORLD PETROLEUM CONGRESS, Paris, 1937.

The fact that petroleum-like hydrocarbons could be prepared from a mixture of carbon monoxide and hydrogen (water gas) was discovered in 1923 but it was not until 1933 that the idea reached the stage of a test on a factory scale. The first operations disclosed that, for technical success, solutions would have to be found for the following problems:

1. Lengthening the life of the contact mass from four or six weeks to as many months;
2. An inexpensive construction for the contact chamber and the plant for removing sulphur;
3. A practicable method for regenerating the rare metals and metal oxides from used contact masses;
4. Transformation of the primary synthetic product (called "Kogasin" by Fischer) into a marketable gasoline (only that part of the primary product boiling up to 140 deg. C. is usable without addition of lead to correct its low octane rating).

At the present time these problems are regarded as solved. New and efficient processes have been worked out for obtaining a sufficient volume of synthetic gas, using coke or lignite briquettes. After passing the first contact mass the primary product contains 92 percent of liquid products, of which 22 percent is gas oil, 10 percent solid paraffins and 68 percent of liquids boiling up to 200 deg. C.; the proportion of olefines in the lower boiling liquids ranges from 30 to 55 percent; the gaseous products are rich in propylene and butylene. The yield of total primary product is between 120 and 130 grams per cubic meter of water gas. The liquid products are convertible into marketable gasoline to the extent of 80 percent by the known methods. The gas oil, which has a cetane number above 100, can be recovered separately and used to improve low grade diesel oils from other sources such as tar oils. Or high grade lubricants may be produced.

A question frequently asked is whether the synthetic process can be altered so as to produce a wider range in the composition of the primary product. With the contact masses now in use no material change in the boiling curve of the primary product is possible. By increasing the carbon monoxide content of the entering gas it is possible to increase the olefine content without materially changing the ratios of the various fractions, which makes it possible to obtain by polymerization a larger proportion of high molecular hydrocarbons. The paper is profusely illustrated.

Gasoline from Oil Seeds—M. Friedwald, in REV. PETROLIFERE, No. 734 (1937), pp. 597-599.

There are certain regions where there is a large production of oil seeds for which no remunerative market is available, and on the other hand where supplies of motor fuel are high in cost and difficult to obtain. Such conditions prevail in some of the French African colonies, and have appeared to warrant serious efforts to exploit this raw material. There is now in operation at Segou, in French Soudan, an installation having a capacity for treating two tons of oil seeds a day. By dry distillation there is obtained a primary oil distillate which is catalytically transformed into petroleum products—gasoline, kerosene, gas oil, etc.

An improvement on the original process of obtaining petroleum from oil seeds has lately been worked

out by Lege in the laboratories of the Sorbonne, wherein use is made of a spiraloid furnace. Yields of primary oil amount to 60 percent figured on weight of the raw material. The yield of petroleum products from the primary oil amounts to an average of 80 percent. The cost figures supplied by the inventor of the new process show a satisfactory margin of profit in view of the economic conditions of these regions. There is no lack of raw material in view of the present and possible production of coconuts, palm nuts, peanuts, and other African oil seeds. In any case, here is one perennial source of petroleum that can be relied on when all the oilfields have played out.

ALCOHOL-CONTAINING MOTOR FUEL ON THE BRITISH MARKET—A. R. Ogston, in PETROLEUM TIMES, vol. 37 (1937), pp. 597; 645.

So far as known, England and Australia are the only two countries where alcohol is in use as a motor fuel without direct compulsion of the government other than fiscal regulations that make the use of this material possible. According to the author the best mixture for use under English conditions is 15 percent alcohol, 15 percent benzene and 70 percent gasoline. A disagreeable feature of alcohol-gasoline mixtures is that the alcohol acts as a catalyst in the formation of gummy substances, especially in the case of highly unsaturated gasolines. Aside from this, the chief advantage of alcohol as an addition to motor fuel lies in its high anti-knock value.

USES OF PETROLEUM

DEVELOPMENT OF TEST PROCEDURE FOR EVALUATION OF DIESEL ENGINE LUBRICANTS—C. G. A. Rosen, before AM. PETROL. INST., Colorado Springs, June, 1937.

The lubricant should posses the following qualities: high film strength; resistance to ring sticking; low cylinder and ring wear; insurance of open oil channels and free acting oil controls; low blow-by of gases into crankcase; and economical oil consumption.

In the present state of the art, it is not possible to devise a complete chemical and physical specification which will cover all types of lubricants satisfying the above enumerated characteristics. Careful consideration should be given to each of the following chemical and physical characteristics:

It is imperative that the lubricant be non-corrosive to ordinary babbitt bearings when operating with steel journals and pins.

Homogeneity is a most important factor in all lubricants which are compounded with metallic soaps. The component parts shall not disintegrate in storage or in normal engine operation. The miscibility of all coumpounded ingredients shall be complete over the whole range of temperatures encountered in engine service.

In compounded oils which have metallic compounds as added ingredients, the non-combustible portion, as found by ashing, should not exceed a maximum of 0.18 percent by weight.

Carbon residue by coking should be carefully examined and shall not be of hard abrasive character.

Viscosity shall conform to the limits prescribed for the recommended grades, as required by localized climatic and service conditions. Viscosity should be determined upon the basis of uniformity of oil consumption during the operating cycle, rather than upon minimum consumption.

However, the satisfactory evaluation of a Diesel engine lubricant compels the use of full scale Diesel engine operation. A standard procedure for the evaluation of Diesel engine lubricating oils for Caterpillar Diesel engines has been developed on the basis of considerable hours of testing, and briefly involves the following factors:

Operation at a load speed and jacket temperature which provide a normal field operating condition with which the lubricant must cope.

Use of a fuel conforming to the specifications of present available completely distilled mineral oils. Ignition quality should not be below 40 cetane for uniform results and the fuel must of necessity be clean.

Completion of laboratory tests under controlled conditions—1,000 hours endurance test, during and after which pistons are checked for depositions. Evaluations from this test are made as to ring sticking, cylinder and ring wear, oil channel clogging, blow-by characteristics, oil consumption, and overall appearance. Break-in and short-run high load tests of a character to determine the ability of the lubricant to support oil films during break-in for periods of six hours, two hours and one hour.

Completion of 1,000 hour field tests under actual operating conditions, or at least five units selected to include the entire range of service conditions under normal attention; two units doing heavy plowing on continuous operation; two units performing intermittent service such as shovel or road building operations, and at least one unit providing continuous high duty power delivery. Periodical and final inspections are made.

Complete analyses of these tests and evaluation of results for the satisfaction of the required specifications and standards. The results are measured in terms of minimum requirements for both laboratory and field tests.

PETROLEUM ECONOMICS

FUTURE OF OIL AND GAS WELL SPACING—D. R. Knowlton, before AM. INST. MINING AND METALL. ENGRS., Tulsa, May, 1937; I. P. A. OF A. MONTHLY, No. 2 (1937), p. 21.

The prospects of the American petroleum industry are still clouded by the absurd law of capture, which imposes on the industry an aggravating incubus of underground waste, economic waste and instability. The most serious indictment against the law of capture is that it forces the drilling of unnecessary wells, unnecessary wells being defined as those wells that are not needed to drain an oil pool efficiently and economically. Striking examples are cited of the waste entailed by these unnecessary oil wells. For example, it has been generally conceded by most authorities that the total number of unnecessary wells that have been drilled in the East Texas field may be conservatively placed at 12,500. If we assume that the average cost of drilling these wells is $13,000, then the total unnecessary expense merely for the drilling of unnecessary wells in this field is approximately $162,000,000.

In another analysis a like situation was found in the Oklahoma City field where it was revealed that 404 unnecessary wells were drilled at a cost of $46,600,000.

In a study now being made, the priliminary facts indicate that a conservative estimate of the number of unnecessary wells to be drilled in the United States in 1937 will cost the industry over $100,000,000. This is a staggering amount and is equivalent to approximately one-third of the amount of salaries that will be paid to employees in the producing end of the industry. Or it is estimated that this amount will easily pay for all the dry holes, including the wildcat wells, that will be drilled during the year.

The situation in most of the States is that at the present rate of drilling the allowables per well are falling off rapidly. In Texas alone the average allowable per well in 1933 was over 50 barrels, while in 1936 it fell to approximately 25 barrels per well. If this orgy of drilling continues, it will be only a matter of a short time before all new wells when completed will receive only a minimum allowable and will result in an extremely long pay-out of capital invested. *The remedy is unquestionably fewer wells and better utilization of the reservoir energy as a substitute.*

Most oil States have departed a little from the original law of capture, but hardly beyond the point of an initial attempt to partially allocate oil in place. In some cases this more rational viewpoint has been brilliantly justified. For example, New Mexico is one of the newest oil States and has a comparatively recent statute on oil and gas. Many authorities consider this the most constructive statute in oil and gas legislation. It is the only one which definitely divorces the old "Law of Capture" and adopts the law of "Oil in Place." It has a liberal spacing law which has encouraged the operators to adopt appropriate well densities. The results speak for themselves. During the years 1934, 1935, and 1936 in Southeastern New Mexico 317,000,000 bbl. of reserves were developed with only 820 wells, while in West Texas some 288,000,000 bbl. of reserves were developed with 2,346 wells, or practically the same amount of reserves developed with one-third the number of wells and one-third the development cost. These two areas are very similar in many respects and offer an excellent comparison.

It is the obligation of the industry to instigate an educational program that will have the effect of obtaining proper legislation, in order (1) that the industry may conserve this natural resource, (2) allocate, as nearly as possible to each operator his just share of the oil and gas under his property, and (3) make it possible for the operator to recover the largest amount of this resource with the minimum expense. Otherwise we must certainly expect continuance of a condition, whereunder conservation cannot be practiced successfully.

ECONOMICS OF INVESTMENTS FOR STORAGE OF LIGHT FUELS—W. B. Franklin, before AM. PETROL INST., Colorado Springs, June, 1937.

The quantity of vapor evolved from refrigerated storage tanks is approximately proportional to the amount of butane stored, and is independent of the quantity of admixed base stock for casinghead of 30 lb. to 60 lb. Reid vapour pressure.

When it is required that storage for a given quantity of butane be provided, no appreciable saving either in operating expense or initial investment can be effected by use of base stock for "holding" the butane. However, when it is required that both base stock and butane be stored, these materials, upon consideration of storage expense alone, should be stored together.

For relatively large quantities of light ends, refrigerated storage becomes a more profitable investment than pressure storage when no additional labor is required for operation of the compressor plant. On the other hand, the additional investment required for pressure storage (over refrigerated storage) may be paid out in as little as 2½ years when labor is required. In highly-active service, pressure storage is, in general, the more economical.

Seasonal storage of butane appears profitable for any type of tankage when a price differential of $1.50 per barrel ($2.00 per bbl. as gasoline, less $0.50 per bbl. as fuel) can be realized. In the case of refrigerated tankage requiring no additional labor for operation of the gas plant, seasonal storage may prove profitable for price differentials as low as $0.50 per bbl.

The economics of investments for seasonal butane storage have been compared with the cost of additional vapour recovery. It has been shown that plants operating at butane recoveries in excess of 50 percent, which can realize on additional recovered butane for only a fractional part of the year, may profit by providing storage for excess production of butanes during the summer to meet the seasonal demand rather than by increasing vapour-recovery facilities.

MOTOR FUEL CONSUMPTION NOT UNIFORM—ANON., MOTORENBETRIEB U. MASCHINEN-SCHMIERUNG, vol. 10 (1937), pp. 5-7; PETROLEUM, vol. 33 (1937), No. 23.

Statistics quoted from the D. BGW. ZTG. indicate that motor fuel consumption per vehicle is abnormally low in France in comparison with England, Germany and the United States. Whereas in 1936 England had 2,230,000 automotive vehicles on the road and consumed about 4,500,000 tons of light motor fuel, there were in France, 2,027,000 vehicles that consumed 2,500,000 tons of fuel. This figures out a yearly consumption of 2,018 kg. per English automotive vehicle against 1,233 kg. per French vehicle. The discrepancy is too great to be accounted for by any possible inaccuracy of the statistical data. Further evidence of the abnormal low per car con-

sumption of fuel in France is afforded by German statistics; in that country in 1936 there were 1,290,510 vehicles that consumed 2,300,000 tons of fuel, an average of 1,782 kg. per vehicle, or 549 kg. more than in France. In the same year the United States had 28,086,380 automobiles of all kinds which burned up 54,667,600 tons of gasoline, or 1,946 kg. per car.

The low consumption of gasoline per car in France is due to various causes. The very high taxes paid by French motorists, do not afford a complete explanation, as similar burdens are laid on English, German, and to a less extent on American motorists. One explanation is that France has not recovered from the depression to the same extent as the other countries named and something must also be credited to the proverbial tendency of the French to keep down expense.

It is interesting to note that in an effort both to obtain more revenue and to encourage the greater use of automobiles the French government abolished all specific taxes on automobiles, road taxes, etc. and concentrated the whole burden in the price of gasoline. But the persistence of the low per-car consumption of gasoline is the best evidence of the failure of this maneuver. The number of cars may have slightly increased but this has been offset by a more abstemious use of fuel, i.e. the cars spend less time on the road.

Oil Resources of the British Empire—Oskar Tokayer, in PETROLEUM PRESS SERVICE, vol. 4 (1937), No. 27, pp. 325-327.

There are only three oil producing territories within the British Empire which have a surplus of oil production over domestic requirements, viz. Trinidad, Borneo (Brunei and Sarawak) and Bahrein. India (including Burma) is more than capable of absorbing her whole production, while Canada's output amounts to only a fraction of her own requirements.

The total production of crude oil in 1936 from these different countries within the British Empire was approximately as follows:—

Crude Oil Output in Metric Tons	
Trinidad	1,922,000
India and Burma	1,366,000
Brunei and Sarawak (Borneo)	703,000
Bahrein	639,000
Canada	201,000
Total	4,831,000

Deducting from this some 1,830,000 tons required for local consumption, for fuel used by the oil industry, etc., there remains an exportable surplus of no more than about 3,000,000 tons.

As against this surplus it is interesting to set the following figures of imports in 1936 by the most important oil consuming countries of the Empire:—

Oil Imports in Metric Tons	
Great Britain	10,995,000
Canada	5,597,000
Australia	1,730,000
India (including Burma)	953,000
Union of South Africa	808,000
New Zealand	448,000
Total	20,531,000

Thus the 3,000,000 tons of oil, mentioned above, would be sufficient to cover not much more than a quarter of the oil requirements of Great Britain alone. South Africa, Australia and New Zealand, which are entirely dependent on imports, themselves purchased from abroad in 1936 about 3,000,000 tons of mineral oil, while the import requirements of the producing countries, India and Canada, was in the neighbourhood of 6,500,000 tons. The exportable surplus of the producing countries was thus only some 15 percent of the total import requirements of the leading countries of the Commonwealth.

While oil production in Trinidad and Bahrein is still capable of a substantial increase, the likelihood, so far as can be ascertained at present, of any very large increase in the oil output of India, Brunei and Sarawak and Canada, is not to be counted on.

Self-sufficiency in oil is from the point of view of the British Empire not only an unattainable ideal, but, if it could be obtained, would be to a large extent a luxury and not, as certain continental countries believe it to be for themselves, a strategic necessity.

Five Years of Mineral Oil Tariffs in the U. S.—Oskar Tokayer, in PETROLEUM PRESS SERVICE, vol. 4 (1937), No. 26, pp. 319-321.

The first mineral oil tariff in the United States was imposed five years ago (June 21, 1932). The effect was to severely cripple imports of crude oil and fuel oil, while the duty was practically prohibitive on imports of the lighter products. These tariffs were imposed for the special benefit of the smaller American producers, but what benefit they got from the tariff was completely nullified by the discovery of the rich East Texas field, where crude oil prices fell to as low as five cents a barrel. Later the price rose to $1.00, but for this increase in price the tariff is said to be in no wise responsible.

While it is apparent that the import duties had no visible effect on the American crude oil markets, there is no doubt that they had serious repercussions in many directions. The quantities of crude oil and finished products which had previously been absorbed by the United States were largely diverted to other markets, with a consequent loss to America's export trade with those countries. Furthermore, the duties resulted in a heavy decline in imports of those crude and heavy oils which the United States needed to supplement its own production. This has proved particularly unfortunate in view of the large expansion in American demand for heavy oils, which has resulted in a growing shortage of fuel oil, necessitating an increase in crude oil production and runs-to-stills beyond what would otherwise have been necessary. This has meant not only an undue increase, at times, in gasoline stocks but an uneconomic utilisation of the crude oil available owing to the obligation to leave in the fuel oil fractions which might have been used with better advantage for the production of more valuable products.

The heavy oil position in America might be considered reason enough for the withdrawal of a measure which is of no real benefit either to the individual or to the community. Yet there are quarters in America where the present fuel oil duty is not considered sufficiently high.

Even the maintenance of the present import tariffs constitutes a burden which, under existing conditions, presses heavily on the consumer and causes unnecessary difficulties to the oil industry. It may well be that, if the present developments in American consumption continue, it may prove essential to revise the tariff policy so as to bring it more into line with the country's economic needs.

GENERAL

Co-operative Pipe Tests—C. W. Froome, before AM. PETR. INST., Colorado Springs, June, 1937.

This is a progress report of the engineering subcommittee on pipe, division of production, A.P.I.

The present report is concerned with tests designed to show leak resistance of threaded joints having errors within suggested specifications. Tests were made on joints whereof the threads were not in accordance with specifications in one or more particulars but perfect in all other respects, the idea being to test relative importance of a specified error considered by itself and in association with one or more other errors. Errors in taper, pitch thread depth and thread angle were thus considered separately and jointly. Method of testing was to apply methane under various pressures and then to test the joint for leaks.

The general result shows that the more nearly perfect the joint, i.e., the more closely the threads comply with the existing specifications and tolerances in the matter of thread errors, the more perfect is the seal. The most important error seems to be that relating to thread taper; threads having tapers deviating from the correct taper by the now allowed tolerances do not lend themselves to making a tight joint without thread injury. Also, ample thread lubricant is necessary to make any joint tight under high gas pressure.

The partial results here discussed positively indicate the necessity of more serious consideration of tolerances and suggest that if good joints are to be expected, threading practices are in need of improvement. The tests and observations here reported on the products now being furnished lead to the following conclusions:

Adequate and definite thread specifications are vitally necessary.

Instruments of sufficient accuracy to check threads within the specifications must be provided.

Sufficient inspection by using the above instruments should be carried out by the manufacturers.

To avoid accidental shipping of poor threads, the threading equipment should be of such a nature as to easily produce threads passable under the specifications.

Specification as to speed and torque to be used in making up couplings should be adopted and enforced.

Proper care should be exercised to protect the product after inspection at the mills.

Can Modern War Demands for Automotive Fuel Be Met?—F. Friedensburg in PETROLEUM, vol. 33 (1937), No. 24, pp. 1-6.

All modern armies are being motorized on a large and increasing scale; to what ultimate extent the fighting forces will come to depend on mechanization is not yet clear, but the tendency is so pronounced as to raise the question of how the necessary fuel is to be provided, considering the present geological and technical outlook of the petroleum industry. One thing is certain: a deficiency of motor fuel would paralyze a modern army as completely as a deficiency of guns and powder, and lead to its certain defeat.

How much of petroleum products will the modern army of a great power require? During the last year of the great war the consumption of motor fuel on the Allied front in France was at the rate of 500,000 tons a month. Various recent studies of the subject indicate that in the next European conflict the requirements of 1918 will at least be doubled. It is true that the number of airplanes in action at the end of the last war was greater than the number of planes that will be ready at the outbreak of the next; but the 1918 planes were mostly single-motored and of short flying radius, not to be compared with existing giant, multimotored air ships with wide radius of action. On the other hand, modern war tanks are now much more numerous and powerful, artillery is more completely motorized and the naval forces are now practically exclusively on an oil-fuel basis. For these reasons a doubling of the 1918 requirement seems a modest estimate, and this without taking into account the need for oil products behind the front.

A French expert (Berthelot) estimates that France will need 12-15,000,000 tons a year in wartime. Another expert (Hesse) estimates that Japan would need 15,000,000 tons, of which 8,000,000 tons would be consumed by the navy in the form of bunker oil and Diesel fuel. Other great powers would scarcely need less.

How are these necessities going to be supplied? The answer is that they can only be supplied (1) from domestic production, and/or (2) by imports. Alternative (1) is at once excluded so far as concerns Germany, France, Great Britain and Italy, none of which are now producing enough petroleum in their home territories even for peace-time consumption. Alternative (2) is exposed to the risks involved in military blockades, political boycotts (neutrality restrictions), lack of foreign exchange, lack of shipping, etc.

The positions of the great military powers as regards their present production and consumption of petroleum, as of 1936, are indicated in the accompanying table.

Production and Consumption (in million tons)

	Production	Consumption	Excess or deficiency
United States	149.0	139.0	+10.0
Russia	26.0	18.5	+ 7.5
Germany	0.4	5.1	— 4.7
Japan	0.3	3.8	— 3.5
France	0.1	5.8	— 5.7
Great Britain	.....	10.8	—10.8
Italy	.....	2.7	— 2.7

From this it will be seen that only two great powers, the United States and Russia, are even now supplying their peace time requirements. In this connection no consideration is given to colonial oil production. Great Britain obtains comparatively little oil from empire sources; Italy, Japan, and France practically none. One answer is the home manufacture of synthetic petroleum, but facilities for this purpose on the scale required are non-existent and could hardly be created except at great cost and in a long time. Another answer is a war reserve, but this also involves enormous technical and defense problems, and it does not appear that any country has a stored reserve that even approaches adequacy.

The conclusion is that, barring unforeseen developments, the next war involving the great powers must be relatively short.

FURNACE-CLEANING OF LINE PIPE—Frank B. Taylor, in OIL WEEKLY, vol. 86 (1937), No. 4, pp. 44-48.

Cleaning of line pipe as a first step in reconditioning is effected by the Oklahoma Natural Gas Company, by subjecting the pipe lengths to a red heat for a short length of time. The operation is effected in a specially built gas-fired furnace at a central location. The operation is simple, consisting in heating the furnace red hot and passing lengths of pipe (up to 20-in. in diameter) slowly through it.

Effect of this treatment is to thoroughly loosen all scale so that incrustations can be quickly removed by means of a steel brush. The joints are then painted or coated when cooled to a point where the heat will not blister the paint. When paint is thus applied to the warm surface it makes a better bond than when applied cold. The economics of the installation are considered satisfactory.

CHEMICAL COMPOSITION OF ROUMANIAN PETROLEUM ACCORDING TO REGION AND FORMATION—N. Danaila in MON. PETROL. ROUMAIN, World Petroleum Congress Number 1937, pp. 117-120.

Roumanian crude oil is obtained from three main geological divisions: Oligocene (4 districts) Meotien (9 districts) and Dacien (3 districts). Aothough all petroleum from all districts contains aromatic hydrocarbons, there is no apparent connection between aromatic content and geological occurrence, either as between regions or as between horizons in the same vertical section. The highest average percentage of aromatic hydrocarbons (4 percent) occurs in the Moreni and Baicoi districts; the lowest (0.3 percent) in the meotien of the Ochuiri district. About 84,775 tons of aromatics is contained in 3,346,631 tons of crude; this is enough to supply the peace and war time need of the country for aromatics, povided that an economical method is found to separate them from the other associated hydrocarbons.

BOOKS

MANUAL ON GEOPHYSICAL PROSPECTING WITH THE MAGNETOMETER—by J. Walter Joyce. Published 1937 by U. S. BUREAU OF MINES. Sold under a cooperative agreement with American Askania Corporation, Houston; paper; 129 pages, 53 illustrations; $1.50.

This manual on magnetic prospecting with the Schmidt-type magnetometer is one of a series being prepared by the United States Bureau of Mines to describe the theory, instruments, field technique, and some of the fundamental principles that underlie the interpretation of various methods of geophysical prospecting. Emphasis is placed on the fact that this monograph is one of a series; more than once the author stresses the importance and desirability of using several methods on each geophysical problem; when each of several methods, of which a magnetometric survey is one, point to the same conclusion, that conclusion attains a high degree of plausibility.

In order that the magnetometer may take its due place among the other paraphernalia of geophysics it is necessary that its principle and operation be thoroughly understood and reduced to practice. In other words, magnetometric surveyors should have at their disposal a fairly complete manual of instructions; such a manual is provided in the present work. The author sets out to familiarize the reader with the fundamental principles that underlie the operation of the Schmidt-type magnetometer; to describe the physical features of the Schmidt magnetometer; to discuss various factors that influence observations; to indicate corrections to be applied to field data; to enumerate the precautions to be observed in the handling and use of the instrument; to describe field procedure in operating the instrument; to cover possible sources of difficulty in operation and their remedy; to indicate methods of determining instrument constants; to describe various methods of presenting magnetometer results; and to outline certain fundamental ideas that underlie the interpretation of magnetic data.

These various points are lucidly explained, and the text is fortified by numerous references to the literature. In his closing paragraph the author takes occasion to emphasize the fact that magnetometric data must be interpreted on the basis of ample experience and due recognition of all the known geological and physical factors involved.

U.O.P. LABORATORY TEST METHODS FOR PETROLEUM AND ITS PRODUCTS—compiled and edited by Charles Wirth, 3rd, Frank J. Vitovec, Jr. and associates in the U.O.P. laboratories; published 1937 by UNIVERSAL OIL PRODUCTS CO., Chicago; 250 pages; $3.00.

This book is a collection of some 100 methods for testing various petroleum fractions, from gaseous hycrocarbons to coke; these methods are in use in the Universal Oil Co.'s laboratory, some of them over a period of years, and the authors assure us that they have all been thoroughly tested. They use as a fundamental background all existing test methods for petroleum products that have been standardized by the A.S.M.T. and many others that have been developed in the Universal and other laboratories.

The work is directed especially to the small refiner with limited personnel and a few facilities for consulting the literature.

The directions for executing the various tests are fairly full and clear and should easily be followed by laboratory operators. References to original sources are also included.

MINERAL RESOURCES AS A POLITICAL AND MILITARY FACTOR IN WORLD POWER—by F. Friedensburg; published 1937 by VERLAG FERDINAND ENKE. STUTTGART; 268 pages, 17.80 R.M. (in German).

The author, who is a recognized authority on world mineral resources, surveys the mineral riches of European and North American countries with particular reference to the role these resources could play, in behalf of the countries possessing them, in future economic, political or military contests. Naturally, the single item of petroleum looms large in such a discussion; this raw material is by far the most weighty factor in any consideration of military problems.

As would be expected from a citizen of one of the "have not" nations, the author emphasizes the unequal distribution of natural resources, an inequality that in many instances cannot be overcome by even the most thoroughgoing utilization of such resources as the unfortunately situated nations have at their disposal. From the standpoint of these nations there is an urgent necessity for a freer international exchange of mineral raw materials. But there is nothing hysterical about his insistence on this point. The book is both factual and scientific, and brings to light much material that will interest the student of modern world economics.

NOMENCLATURE OF TECHNICAL TERMS IN THE PETROLEUM INDUSTRY—Prepared by the Committee on Nomenclature, Methods of Measurement and Related Questions and Reported to the second WORLD PETROLEUM CONGRESS (Paris 1937) by Pierre Minard.

This is a thick bundle of mimeographed sheets giving a petroleum dictionary in three languages—French, English and German. The arrangement is in three columns to the page, the central column giving the Anglo-American terms in alphabetical order, with the French and German equivalents on either side. It is thus easy to translate the Anglo-American expressions into foreign terms, but not vice versa; other volumes will doubtless be issued with French and German respectively occupying the central position.

The terms admitted to this lexicon relate to company and association organizations, units of measurement, geology, prospecting, drilling, oil well operation, fabrication, refining, names of products and their characters, uses, transportation, distribution and sale. It is therefore a useful aid where it is a question of transposing the concepts of Anglo-American oil men into the other two languages.

The editor has nearly always been able to find simple equivalents in all three languages, but in not a few cases he has been stumped in his effort to make the lingo of the Oklahoma or Pennsylvania oilfields intelligible in la belle France or in Hannover. It is easy to translate "gas," but "gas cut" requires a long circumlocution to render it intelligible to a Frenchman; even more tortuous are the rendition of "go-devil", "Christmas tree", "rock the well", and even "shoe"; and when it comes to translating "farewell sand" or "roughing cut" into German the lexicographer simply throws up the job. However, it is fair to say that it is a creditable first step toward filling a long felt want.

PETROLEUM DEVELOPMENT AND TECHNOLOGY, 1937—Compiled by the Petroleum Division of the AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS and published 1937 by the Institute (New York); 689 pages; $5.00.

This volume contains the papers and discussions (many of which are not published elsewhere) presented before the Petroleum Division of the A.M.M.E. at the Los Angeles and Fort Worth meetings, in 1936, and at the New York meeting in 1937. There are 34 of these papers assembled in six chapters (I to IV and VI and VII) under the following general headings: Production Engineering, Production Engineering Research, Stabilization, Petroleum Economics, Petroleum Engineering Education, and Refining. Chapter V, with an introduction by James Terry Duce, deals with production, wherein various authors review the course of oil production in the various states and districts of the United States and in foreign countries.

As with previous volumes of the series, this one contains plenty of informative and suggestive matter for members of the industry.

GRAVITATIONAL SURVEYING WITH THE GRAVITY-METER—L. M. Matt-Smith, in GEOPHYSICS, vol. 2 (1937), No. 1, pp. 21-32.

This paper discusses briefly the history of gravity meters and the importance of gravity surveys for the prospector. The gravity-meter, an instrument which measures gravity differences directly, has now been developed to the point where it is superior to the torsion-balance in several important particulars for the purpose of making gravitational surveys. It is able to survey a given area with sufficient detail for most petroleum surveys in about one-third the time if we consider crews of comparable size and cost. Accuracy will be better by a factor of two or more, the advantage becoming greater as the size of the survey is increased. The gravity-meter is much less affected by local terrain irregularities. This makes it possible to operate on the roads instead of having to find a suitable spot, as is the case with the torsion-balance. It also enables the gravity-meter to do more reliable work in most areas and very much better work in poor areas.

U. S. S. R.

Official Figures for Soviet Oil Operations

	Crude Production (bbl.)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (ft.)
January	15,476,300	499,233	13,839,000	443,310
February	13,247,500	473,029	12,167,400	359,317
March	15,273,300	492,687	13,803,300	540,510
April	15,749,300	524,943	13,813,800	542,390
May	17,409,000	561,581	15,457,400	591,510
June	16,250,000	534,516	14,200,000	520,000
July	15,200,000	522,581	14,200,000	525,000
Total 7 Months, 1937	108,605,400	512,346	97,480,900	3,522,037
Total 7 Months, 1936	112,018,200	525,907	98,080,700	3,924,231
Total 1936	191,694,100	523,754	173,408,200	6,958,916
Total 1935	176,688,100	497,713	146,705,000	4,858,465
Quota 1937	225,120,000*	617,000	200,000,000	9,240,000
Quota 1936	213,500,000	584,931	175,000,000	7,100,000
Quota 1935	212,310,000	458,042	171,500,000	5,214,000

*Revised from 241,500,000. Crude conversion: seven barrels = one ton.

SINCE dismissal of the heads of various Baku fields in May the reported revival of plan fulfillment in Soviet crude production has been of short duration. Operations jumped from 96 to 103 percent, but this improvement lasted only during the latter part of May and first of June. July operation indices are back where they were before the purge, which is not over. The dragnet hauls in further class enemies, new accusations and dismissals follow, while self-criticism is at a peak.

S. Slutzki, head of the Azerbaidzan oil industry since 1935, has been dismissed as an enemy of the people. In 1928 he was representative of Soyusneft export in Scandinavia, and was in New York the following year. After his return to Moscow in 1930 he became assistant to Barinov, whom he succeeded as head of Baku when the latter became head of Glavneft. Slutzki's dismissal was fore-shadowed in the June issue of WORLD PETROLEUM.

ZA INDUSTRIALIZATIU for July 14th, 1937, gives an idea of the conditions behind the Slutzki removal. Baku was fulfilling plan for almost a month-and-a-half—many oilfield groups exceeding their quotas—and preparations were being made for a compulsory daily average of 470,000 bbl. during the third quarter. Instead, early July saw a drop in daily average to 437,500 bbl. To live up to plan Baku must have more operating wells, for the lack of which the journal blames the field management's inability to utilize properly the pipe reserves, the low quality of drilling, and the delay in eliminating the results of wrecking activities. It goes on to say:

"The management of Baku, headed by Slutzki, has done all it could to prevent such liquidation." Field managers were apparently lulled into a false sense of security by the increase in output during May and June. Visualising gushers and flush production they neglected to rehabilitate wells requiring slight repairs. "Slutzki —although giving orders to do something about this situation—ingeniously prevented definite action," states the Russian paper. "Idle wells at Baku and inexpedience in bringing them under operation have incurred arrears amounting to over 7,000,000 bbl. of crude. Improvement during May and June should have covered this without any difficulty, and if the improvement had been carried further all plans would have been fulfilled with excess—but class enemies prevented this. The commission of A. Serebrovski and M. Barinov uncovered unsound finances when investigating Baku, which prevent the drilling organization from obtaining equipment. This problem requires immediate attention, but before everything, comes the problem of removing Trotzki elements."

Bortz, Peterson, Ginsburg, Butchazki, Shorov, Nuremberg and Partnov were removed some time ago. Yefuni, Alexeev, Pokrovski and Batulin were removed later. Next were Ganshin (Bashkiria), Beresin (Emba), Riabovol (Grozni), Prozumentic (Baku) and Slutzki—who has been replaced as head of Baku by I. Gulbis and whose removal coincided with the removal of Rosengolz from the Commissariat for Foreign Trade. All were declared Trotzkyists. Their places were filled by men presumably more devoted to Marxian theories, or perhaps better Stalin stalwarts. But will these accusations, removals, or executions improve the situation and bring oil to the surface? What about the lack of accessories for wells and tractors; and the lack of mental stimuli, by way of appreciation of work done, for those who must operate them? Human needs are not fed with theories, plans are not fulfilled by orders, nor does shooting of executives create freedom from fear among the personnel.

Operation indices of the Russian oil industry during a representative day of July indicate that Baku is second to Sakhalin, other areas being in a definitely bad condition.

Plan Fulfillment by Russian Oilfields in July

Field	Percent
Baku	92
Grozni	66
Maikop	75
Bashkiria	55
Emba	63
Voroshilov	56
Kalinin	63
Sakhalin	94
Turcomaneft	80

Recently a new oil trust was formed under Volganeft to operate properties at Sizran, Samarski Luka, and Buguruslan, and other Volga oil regions discovered recently. These properties were previously operated by Vostockneft, which is practically a prospecting organization. An equipment plant will be erected at Sizran to supply the new fields.

J. WEGRIN.

Soviet Oil Exports

Product	January-May, 1937 Tons	Rubles
Crude	40,531	1,463,000
Gasoline	259,180	19,074,000
Kerosene	120,043	9,228,000
Lube oil	90,825	11,073,000
Diesel oil	3,412	124,000
Gas oil	167,726	9,730,000
Fuel oil	270,331	9,782,000
Others	1,448	373,000
Total 5 months	953,496	60,846,000

Exports to Individual Countries

England	214,345	13,545,000
Spain	117,861	8,442,000
Germany	104,808	7,353,000
France	60,389	5,476,000
Japan	57,925	3,301,000
Sweden	29,069	2,622,000
Italy	21,691	2,108,000
Iran	16,886	1,158,000
Lithuania	12,791	977,000
Denmark	11,155	902,000
Belgium-Luxembourg	9,241	1,193,000
Turkey	7,653	593,000
Finland	6,365	573,000
Holland	5,992	489,000
Esthonia	5,874	488,000
Mongolia	2,720	454,000
Switzerland	1,559	122,000
West China	1,585	351,000
Afghanistan	1,532	323,000
Others	263,877	11,367,000
Total	953,496	60,846,000

Imports Gasoline into U. S. S. R. from U. S. A. during the first five months of 1937 were 8,642 tons valued at 1,045,000 Rbl.

BLACK Sea exports of Russian oil were down in the first half of 1937 compared with the corresponding six months of last year, according to the U. S. Department of Commerce, the totals being 6,783,595 bbl. and 9,755,417 bbl., respectively. This indicates a continuation of the decline last year from exports during 1935.

Product	1936 (Barrels)	1935 (Barrels)
GASOLINE:		
Abroad	4,377,000	5,923,000
To other U.S.S.R.	1,074,000	1,818,000
KEROSENE:		
Abroad	2,206,000	2,669,000
To other U.S.S.R.	140,000	494,000
FUEL OIL:		
Abroad	8,389,000	10,780,000
To other U.S.S.R.	106,000	170,000
LUBRICATING OIL:		
Abroad	2,110,000	2,352,000
To other U.S.S.R.	216,000	112,000
TOTALS:		
Abroad	16,872,000	21,724,000
To other U.S.S.R.	1,536,000	2,594,000

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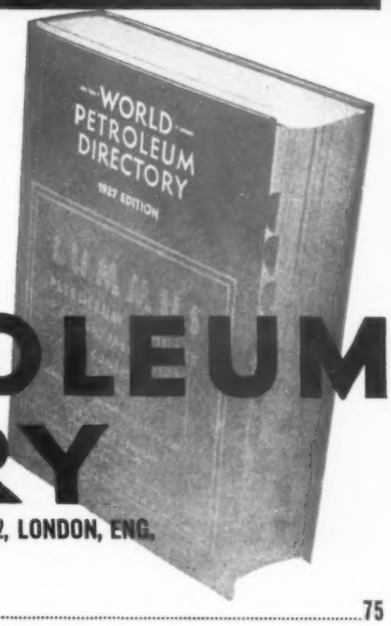

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ARGENTINE AGREEMENT

(Continued from page 35)

extension of productive areas and it is considered doubtful, in view of the growth of market demand, that imports can be dispensed with.

The agreement provides for a uniform price of 23 cents (Argentine) per liter or approximately 26 cents per gallon throughout the country. It is to run for three and a half years but will be automatically extended to Dec. 31, 1941 unless notice of termination is served by one of the parties prior to June 30, 1940 and may continue from year to year under the condition of six month's notice of termination by any one of the signatories.

Administration of the agreement is in the hands of a special tribunal to which the various companies will make full reports of their operations. The tribunal consists of five members, two appointed by the YPF and two by the Standard and Shell interests, with Dr. Eduardo Bullrich as president and Dr. Alfonso Canale Demaria as secretary. This tribunal has authority to assess fines for infractions of the terms of the contract and is the medium through which the companies must make application to the government for higher prices if such are found to be necessary.

Having entered into this agreement with the other leading companies the Standard interests naturally have given up the idea of abandoning their position in Argentina. It is believed that the understanding arrived at among the three leaders will result in a more satisfactory marketing situation than has existed in Argentina for a long time past.

JAPANESE OIL POLICY

(Continued from page 64)

23 new wells will be drilled, in addition to the existing 52 wells, in the oil fields in Okha, Katangli and Ekhabi under the control of the company. During the first year of the five-year plan starting 1937 eight new wells will be drilled. The company plans to have 75 working wells producing an annual total of 3,220,000 bbl. of crude oil at the end of the fifth year, 1941. Of the 3,220,000 bbl. which is apparently the goal of the present project, the company intends to import 2,520,000 bbl. into Japan proper.

So much for the domestic sources of Japanese crude. Refining capacity in Japan in 1936 was 17,160,000 bbl. in 76 refineries. By the end of 1937 it is expected that an additional 2,891,430 bbl. of refining capacity would be available as a result of present construction. During 1936 the 76 refineries now in operation treated 12,068,600 bbl. of crude. Hence refining facilities were

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utilized to only 70 percent of capacity.

Plans for production of petroleum from coal and shale, the second point in the national petroleum policy, are taking concrete form in the organization by the government of a $29,000,000 holding company which plans ultimately to produce some 12,000,000 bbl. of gasoline. For the past few years the South Manchuria Railway Company and the giant Mitsubishi and Mitsui interests have been operating trial coal liquefaction plants. The government itself set aside $4,350,000 in the current budget for a model plant.

The proposed semi-official holding company through which the government now intends to administer its policy concerning the national liquefaction industry, will be capitalized at $29,000,000 at the start. Upon formal organization, the company will float debentures to the amount of $58,000,000 in order to raise funds for financing liquefaction projects in the country. The government, reportedly, plans to increase the capital of the company to $145,000,000 and to advance the annual gasoline production in the liquefaction industry to 12,000,000 bbl. within the coming five years. Five percent dividend will be guaranteed by the government. Increased revenue from import tax on gasoline and the gasoline consumption tax, included in the recent wholesale tax increase plan, will be used as the principal resources. The company will not engage in industrial enterprises on its own account but will handle government investments in private liquefaction projects.

Under the impetus of the government drive toward the stabilization of the national fuel policy aiming at self-sufficiency in liquid fuel, the Mitsui and the Mitsubishi interests, two outstanding financial leaders in Japan, have decided to embark upon coal liquefaction on large scale. Encouraged by successful trials and experiments at the Ohmuta plant, the Mitsui leaders have come to consider seriously the launching of coal liquefaction on industrial scale. According to the first stage plan recently announced the Mitsui interests contemplate forming a $5,300,000 company under the name of Mitsui Coal Liquefaction Company. Its plan calls for annual production of 280,000 bbl. of gasoline.

The Mitsubishi interests apparently have been considering the liquid fuel problem prior to the Mitsui organization. Results at the Ohi trial plant were reported to be encouraging enough to induce the Mitsubishi leaders to decide upon taking to the liquefaction enterprise on business scale.

The State Government of Manchukuo has also decided to establish a semi-government coal liquefaction company in addition to the existing Manchurian Petro-

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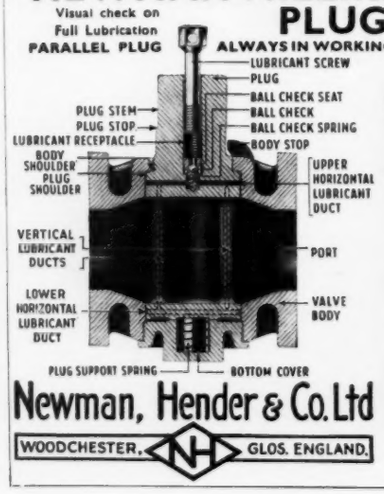

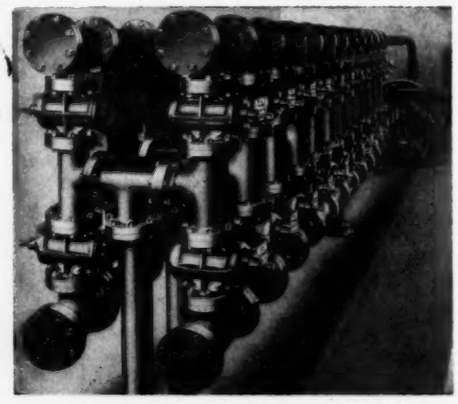

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leum Chemical Company. The new company, tentatively named the South Manchurian Coal Liquefaction Company, is capitalized at $14,500,000, jointly financed by the government of Manchukuo, the Mitsui interests, the Manchurian Coal Mining Company, the South Manchuria Railway Company and the Manchurian Petroleum Company.

A new liquefaction plant of the company will be constructed at Fowsin where coal is abundantly available. Starting with an annual production of 240,000 bbl. of liquefied gasoline in 1938, the first year of operation, the company plans to increase the annual production to 2,400,000 bbl. within five years.

In order to protect the management of the company, the Manchukuo government will accept the deliveries of "liquefied" gasoline produced by the company at prices high enough to enable the company to give a minimum annual dividend of four percent.

The law as regards taxation, importation and storage of petroleum and products in Japan has, after considerable controversy, been temporarily stabilized as follows:

Quotas are established limiting sales to certain quantities for refiners and lesser quantities for importers. In most cases the importers are the large international companies.

Moreover, there is an import duty on products brought into Japan from outside sources. The amount of this duty is shown on page 65 for various products. In the case of gasoline, the duty amounts to approximately 3.5 cents per gallon.

There is also a sales tax on petroleum products, shown on page 65 for various products. In the case of gasoline, this amounts to 1.4 cents per gallon at Tokyo. It varies for different cities.

Another provision of the petroleum law which aroused considerable controversy is the storage requirement. This is intended to keep on hand adequate supplies of petroleum and products in the event of a national emergency as part of the national petroleum policy outlined above. The amount to be kept on hand is established by law as 50 percent of the sales quota for the year, or a half year's supply. To mitigate somewhat the burden of maintaining such excessive storage facilities, the government finally agreed in 1936 to compensate the oil companies for approximately one half of the annual expenditure required for such storage. In 1937, the amounts appropriated for these payments were: for domestically refined gasoline, 32 cents per barrel; for imported gasoline, 29 cents per barrel; for domestic crude or fuel oil, 16 cents per barrel; for imported crude or fuel oil, 12 cents per barrel.